

STUDY TO DEVELOP IMPROVED FIRE RESISTANT AIRCRAFT PASSENGER SEAT MATERIALS PHASE II

By Fred E. Duskin

William H. Shook

Edward L. Trabold

Howard H. Spieth

(NASA-CR-152184) STUDY TO DEVELOP IMPROVED
FIRE RESISTANT AIRCRAFT PASSENGER SEAT
MATERIALS, PHASE 2 Final Technical Report,
20 Sep. 1977 - 30 Jun. 1978 (Douglas
Aircraft Co., Inc.) 379 p HC A17/MF A01
N79-12048
Unclas
G3/03 38860



Prepared Under Contract No. NAS 2-9337 By

McDonnell Douglas Corporation

Douglas Aircraft Company

3855 Lakewood Blvd.

Long Beach, California 90846

for

Ames Research Center

National Aeronautics and Space Administration

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Preface

This is the Final Technical Report submitted under Contract NAS-2-9337 in the NASA FIREMEN program. The report covers the period 20 September 1977 through 30 June 1978.

This program was sponsored by the Chemical Research Center, Moffett Field California. Mr. Larry Fewell was Program Director.

The program was performed at Douglas Aircraft Company, McDonnell Douglas Corporation, Long Beach, California. Mr. Fred E. Duskin was Principal Investigator and Program Director at Douglas Aircraft Company and was assisted by the Materials and Producibility Engineering section and the Space Simulation Laboratory at the McDonnell Douglas Huntington Beach facility.

All data is submitted unpublished, in confidence, to NASA-Ames.

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Abstract

The Phase II study of the NASA "Improved Fire Resistant Aircraft Seat Materials" involved fire tests of improved materials in multilayered combinations representative of cushion configurations. Tests were conducted to determine their thermal, smoke, and fire resistance characteristics. Additionally, a source fire consisting of one and one-half pounds of newspaper in a "tented" configuration was developed. Cushions and seat assemblies will be subjected to this source fire during the Phase III test program. Finally a preliminary seat specification was written based upon the materials data developed by this program and general seat design criteria.

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1.0 Introduction

The purpose of this program is to develop an improved fire resistant aircraft seat. The program is divided into three phases. Phase I, which was recently completed, established a data base with emphasis on thermal characteristics of a wide range of individual seat material candidates. This report covers work accomplished during Phase II which was primarily concerned with the thermal response of multilayer seat material constructions. Additionally a preliminary seat specification was written and a source fire was developed for Phase III full scale seat burn tests.

Using the data base developed by Phases I and II of this program, candidate materials were selected for the individual components of a typical seat cushion assembly, i.e., the decorative fabric covering, the slip sheet or topper, the cushion reinforcement and the cushion. Phase II introduced a fire blocking layer which may be in addition to the other components or integrally combined with them. Burn characteristics of multilayer combinations were determined by heat release tests conducted in a modified Ohio State heat release chamber. This test series was divided into two parts. Part 1 multilayer tests were conducted using a fiberglass cushion in combination with a variety of upper cushion layers. Part 2 selected the most promising upper layers and combined them with a variety of cushion materials. Due to the limited resources of the program, many material selections were primarily based upon functional property tests thereby reducing the number of multilayer combinations.

During Phase II a source fire was developed to be used for the Phase III full scale burn tests. To properly establish a source fire, it was necessary to determine a likely or reasonable fire threat level for an in-flight fire scenario. This was accomplished by conducting an in-service airline survey of combustibles found on or around the passenger seats immediately after the aircraft was deplaned. Using the results of this survey burn tests were conducted of representative combustible materials. These tests determined the repeatability and thermal characteristics of the fires tested.

A preliminary seat design specification was prepared based upon laboratory test data gained from this program and general seat design criteria. This specification will be finalized at the conclusion of the next phase of this program.

The following Phase III of this program will encompass the design, fabrication and burn testing of various seat cushions and finally seat assemblies. Full scale burn tests of contemporary and improved fire resistant seat assemblies will be conducted. Results will be compared to determine the degree of fire resistance achieved by the improved materials and seat designs.

The success of the seat program is dependent upon the program participation of interested seat manufacturers. In an effort to solicit their help a program review was held at Douglas, Long Beach. The review was attended by three seat manufacturers and one cushion supplier. The results of Phases I and II and planning of Phase III were discussed. All companies expressed a definite interest in becoming actively involved in the program.

The following report covers all work accomplished in Phase II.

2.0 SYMBOLS AND ABBREVIATIONS

av	average
BTU	British thermal unit
°C	degrees Celsius (centigrade)
cc	cubic centimeter
cm	centimeter
cm ²	square centimeter
DAC	Douglas Aircraft Company
dm ²	decimeter square
°F	degrees Fahrenheit
FAA	Federal Aviation Agency
FAR	Federal Aviation Requirements
ft	feet
g/cc	grams per cubic centimeter
g/m ²	grams per square meter
hr	hour
in	inch
kg	kilogram
kg/cm ²	kilogram per square centimeter
kg/m ²	kilogram per square meter
kw	kilowatt
lb	pound
lb/ft ²	pounds per square foot
lb/ft ³	pounds per cubic foot
m	meter
mm	millimeter
min	minutes
ml	multilayer (specimen)
NASA	National Aeronautics and Space Administration
NASA-Ames	National Aeronautics and Space Administration, Ames Research Center
N	Newton
PBI	Polybenzamidazole
psi	pounds per square inch
sec	second
TC	thermocouple
TGA	thermal gravimetric analysis
W	watt

3.0 TESTING OF MATERIALS

Phase II material tests were intended to extend the data base established in the Phase I program. Multilayer tests were intended to confirm individual material characteristics and identify combined effects in multilayer configurations which are more closely related to fullscale seat constructions. The test methods were basically consistent with those employed in the Phase I program.

3.1 Follow-on Screening Tests

Materials that were developed or modified after completion of the Phase I testing program were screened early in the Phase II test program in order to expand the data base and increase the number of materials available during selection for multilayer testing. Screening tests were performed in accordance with methods described in Appendix IV. Results of screening tests performed during the Phase II program are reported in Table I. Flash fire propensity data for some of the materials are reported in Table Ia. A list of materials tested during Phase II and other test data can be found in Appendix I-1 through I-5.

3.2 Abrasion Tests, Decorative Cover and Slip Sheet

Due to limited resources, a single decorative cover material was selected based on results of Phase I testing. The Kermel/wool blend fabric 20787 (101) met modified burn tests, demonstrated better thermal stability, developed a strong char and permitted a closer look at one of the new polymers. The selected cover material was then used to test slip sheet materials based on the abrasion between the decorative cover and the slip sheet (Topper).

Abrasion was tested by means of the Wyzenbeek Method per FTMS 191, Method 5304.1. Verification of results were made by the Taber Method per FTMS 191, Method 5306 for 750 cycles using an H38 wheel with 500 gm load. The results of Wyzenbeek Abrasion are reported in Table II. The Taber tests confirmed Wyzenbeek results. The Durette 400-6 fabric (217) showed three large areas of wear and numerous small areas. The S/470 Nomex III fabric (221) only showed numerous small areas of wear. It should be noted that materials were not tested on the basis of equivalent weight and weave but on specific material available to the program and therefore test results are limited in application.

3.3 Adhesive Tests

A silicone adhesive was required for silicone materials but for other materials a contact adhesive was used for assembly. The screening of candidate adhesives was primarily based on tests such as Thermal Gravimetric Analysis (TGA), Animal Toxicity, Flammability and Smoke Generation. Tests were performed per Phase I methods found in Appendix IV. Results of adhesive screening tests are reported in Table III and TGA results in Figures 1 through 5. The results of animal toxicity tests are reported in Table IV. Flash fire propensity data of adhesives are reported in Table V.

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Test & Test Method	Units	(309) 9FR618 Silicone Sponge Kirkhill Rubber	(310) LS Neoprene Foam * T1218 Toyad Corp.	(311) 3-6551 Silicone on Kynol Dow Corn- ing (2)	(312) Tosil Sponge Silicone Japan G.E.	(313) E-300 Urethane Foam Crest Foam Corp.	(314) 147-FR Temper Foam	(315) NO. 200 Polyimide Flex Foam Solar	(217) 400-6 Durette Duck Firesafe Prod	(222) 40-9031-2 PBI Fabric Celanese
Density Weight	lbs/ft ³ oz/yd ²	8.4	7.5	103(0.54)	18.9	3.1	5.9	0.5	4.5	4.2
Burn Test DMS 1511										
Burn Time	sec.	31 (4)	0	0	0	21	4	0	0	0
Burn Length	in	1.4	1.2	0.4	0.3	5.5	3.4	1.4	1.8	0.8
Drip		N.D.	N.D.	N.D.	N.D.	1	2	N.D.	N.D.	N.D.
NBS Smoke DMS 1500										
Nonflaming	90 sec. 4 min.	48 155	65 159	36 97	11 43	39 63	79 140	0 0	0 2	0 0
Flaming	90 sec. 4 min.	39 142	122 228 (1)	30 111	15 51	59 105	288 388 (3)	0 0	6 11	0 0
Pill Test Ignition ASTM D 2859										
LOI	%	26	--	31	43	27	-	38	35	> 86.5
TGA Temp. at 50% wt. loss	°C						570	558		

(1) High smoke density values but will be retained in program.

(2) Dropped from program on the basis of high density.

(3) Dropped from program on the basis of excessive smoke density values.

(4) Small pilot-like flame.

* This foam is reidentified as ALS 125 for commercial production.

DATA SUMMARY CHART

TABLE I

Test & Test Method	Units	(216) 400-11 Durette Needlepunch Firesafe Prod.							
Density Weight	lbs/ft ³ oz/yd ²	10.4							
Burn Test DMS 1511 Burn Time Burn Length Drip	sec. in	0 0 0.6 0.7 ND ND							
NBS Smoke DMS 1500 Nonflaming Flaming	90 sec. 4 min. 90 sec. 4 min.	0 1 6 11							
Pill Test Ignition ASTM D 2859									
LOI	%								
TGA Temp. at 50% wt. loss	°C	525							

DATA SUMMARY CHART
TABLE I (CONT'D)

MATERIAL		TIME TO FIRST SMOKE MIN.	SAMPLE PYROLYSIS TEMP. AT 1 st . SMOKE	FLASH RESPONSE				OBSERVATIONS
NO.	IDENTIFICATION & WT.			NO.	TIME MIN.	THERMAL PULSE HT. - DIVNS	SPL. PYRO TEMP. °C	
309	9FR 618 Silicone Sponge (Kirkhill) 0.51g	0.80	OC 246	1 st .	2.80	13	491	1. Bright Yellow Flash 5" Travel, Dense Smoke
				2 nd .	4.24	64	632	2. Bright Yellow Flash (from Heating Coil)
219	35-4025 (400)-8 Black Preoxidized Batting Heat Treated 0.51g	NO SMOKE	-			No Flash		-
310	LS Neoprene Foam Formula T1218 Toyad Corp. 0.53g	0.72	173			No Flash		Dense Smoke Red Glow Around - Spark
315	No. 200 Polyimide Foam NAS 9 - 15050 Solar Indust. 0.19g	1.60	532			No Flash		Light White Smoke
312	Silicone Sponge Foam Tosil Japanese 0.51g	1.02	438	1 st .	2.64	100	662	1. Small Flash
				2 nd .	3.92	80	769	2. Small Flash, Loud Sound, Light White Smoke
214	DAPCO 15-5 Urethane Foam (D Aircraft Products) 0.52g	0.64	272	1 st .	1.28	63	430	1. 3" Flash No. Sound
				2 nd .	1.84	82	509	2. 3" Flash Yellow Dense Smoke
214	S/470 Nomex 111 Duck Fabric 0.52g	0.88	438	1 st .	3.04	70	930	1. Short Flare Travel Loud Sound, Yellowish Dense Smoke
409	Adhesive RTV - 133 #5	0.80	793	1 st .	1.52	45	721	1. Long Flash Starting at Heating Coil Top Down
				2 nd .	1.84	72	793	2. Whitish/Gray Smoke

FLASH FIRE PROPENSITY TEST - DATA SUMMARY

TABLE Ia

Test Condition	Breaking Strength, lbs/inch		
	Seat upholstery fabric 20787	Slip Cover Fabrics	
		Durette 400-6	S/470 Nomex III
As received	85	70	116
	83	68	113
	83	69	115
	Avg <u>84</u>	<u>69</u>	<u>115</u>
After 20,000 abrasion cycles	85	53	112
	85	49	108
	<u>85</u> (being rubbed by Nomex fabric)	<u>51</u>	<u>110</u>
	87		
	<u>86</u> (being rubbed by Durette fabric)		
	<u>86</u>		
% Loss of Strength.	0	26	4

ABRASION RESISTANCE, WYZENBEEK METHOD
PER FTMS 191, METHOD 5304.1

TABLE II

DATA SUMMARY CHART

Test & Test Method	Units	T685 N/F Columbia Cement	R 1275 N/F Columbia Cement	R 2332 N/F Columbia Cement	EC 1475 3 M Co.	RTV-133 Gen. Elect.				
Weight Thickness	in.									
Burn Test DMS 1511 Burn Time Burn Length Drip	sec. in.	0 1.2 ND	0 1.5 ND	0 1.6 ND	0 1.5 ND	1 1.0 ND				
NBS Smoke DMS 1500 Nonflaming Flaming	90 sec. 4 min. 90 sec. 4 min.	3 4 5 7	9 13 16 18	7 7 8 9	2 3 5 6	7 16 9 24				
Colorfastness Method 5660 Method 5651(B)	Light Crocking									
LOI ASTM D 2863	warp % fill %	> 92	47	79	61	38				
TGA Temp MAX. wt. loss	°C	8	15	7	15	8.5				

ADHESIVE SCREENING

TABLE III

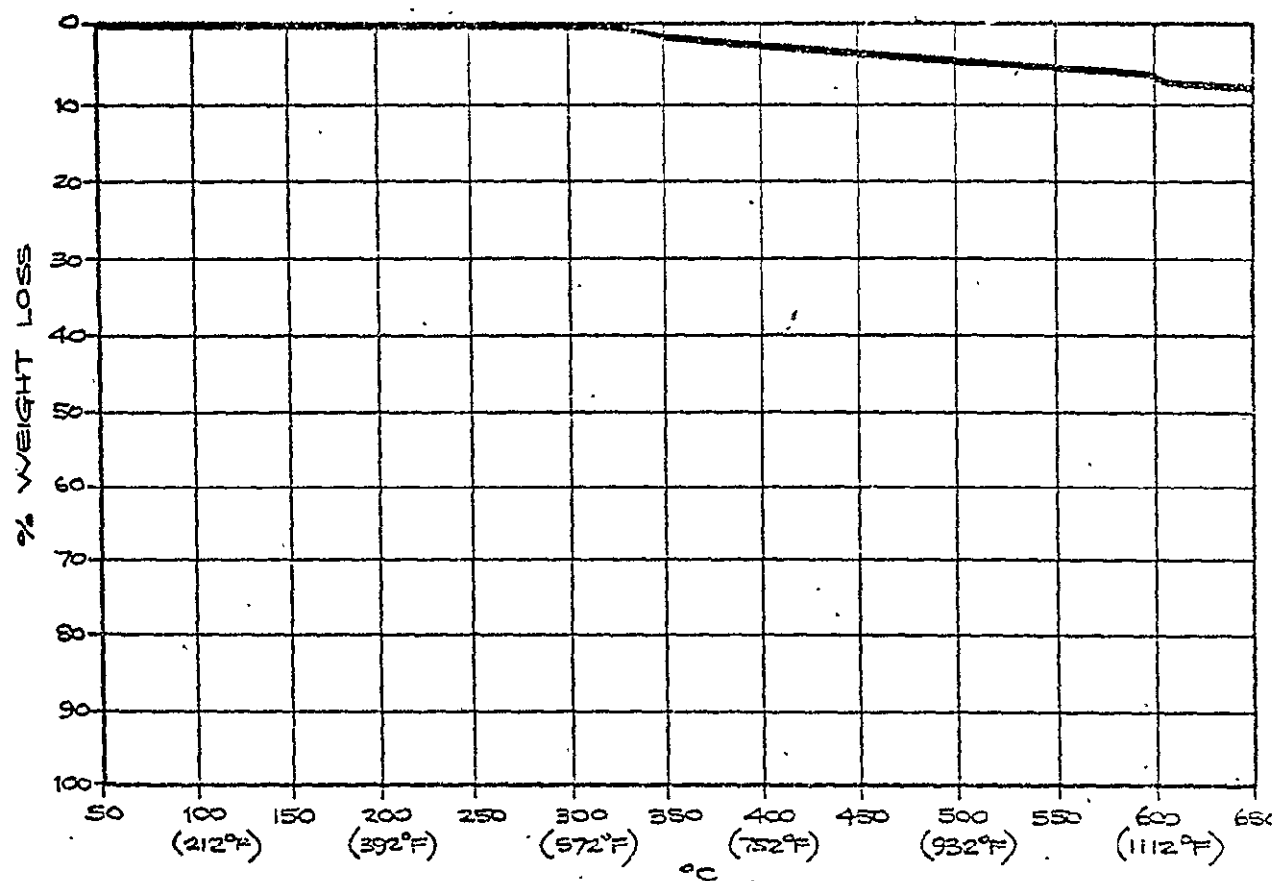


FIGURE 1. TGA CURVE - 685 N/F ADHESIVE (405)

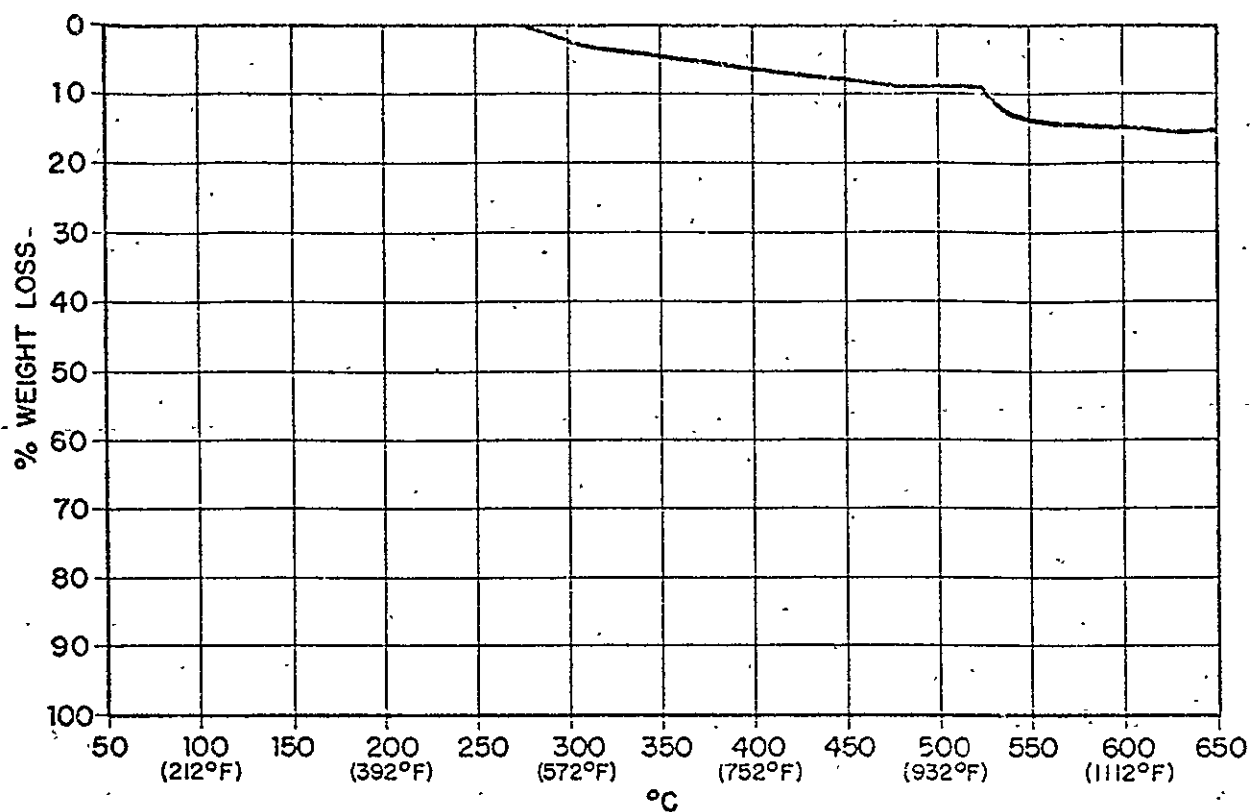


FIGURE 2. TGA CURVE - R 1275 N/F ADHESIVE (406)

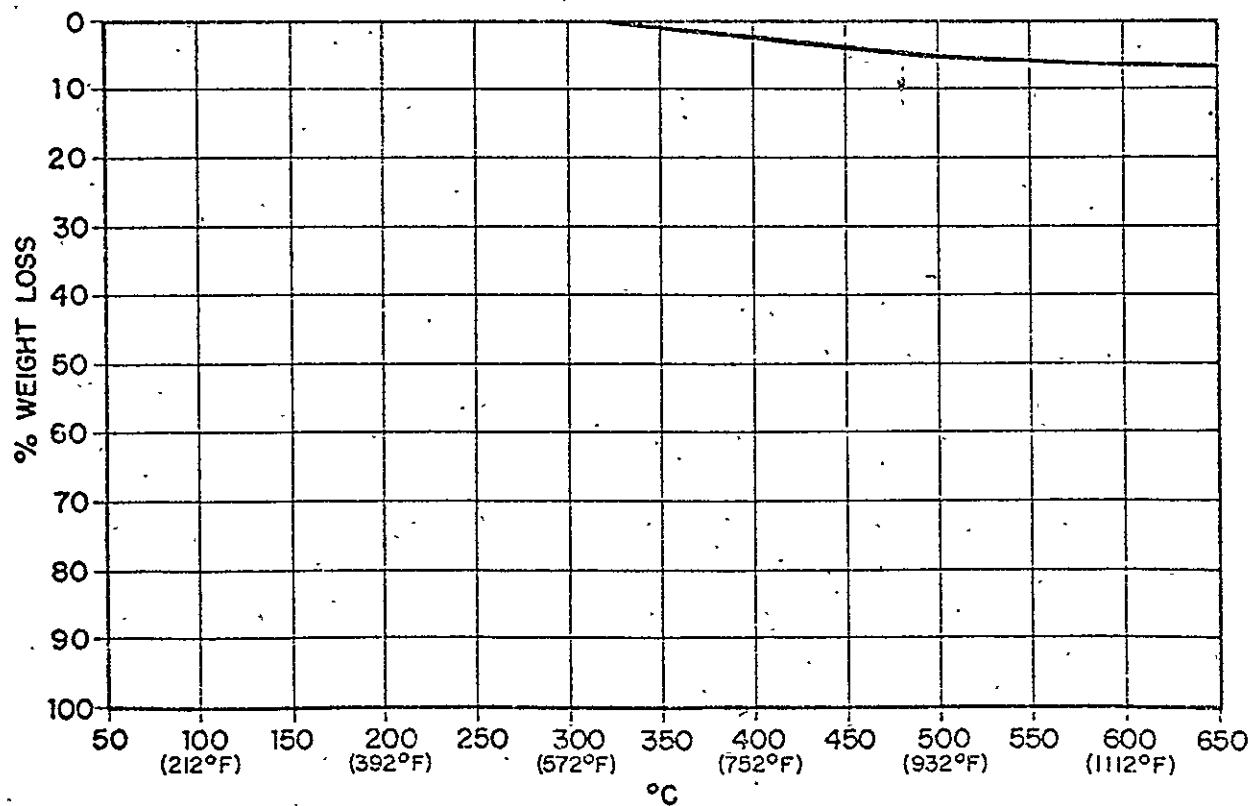


FIGURE 3. TGA CURVE - R 2332 ADHESIVE (407)

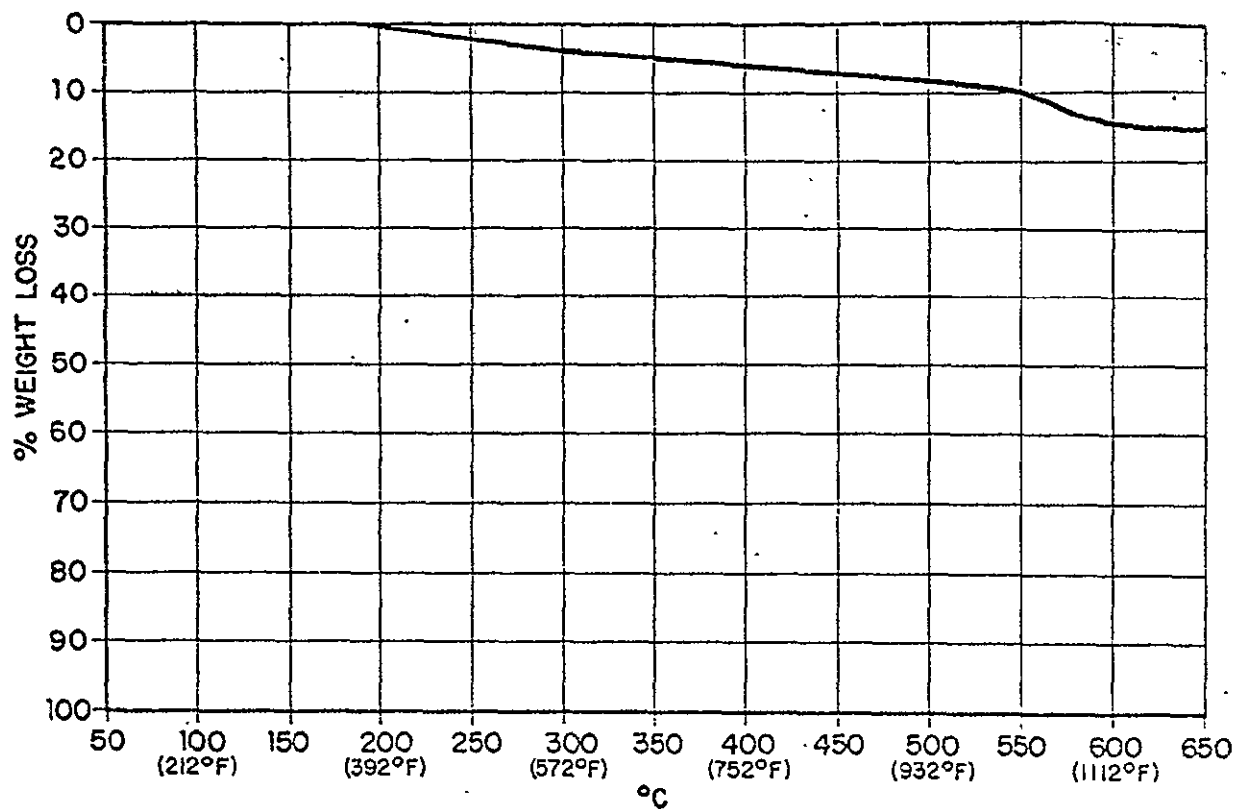


FIGURE 4. TGA CURVE - EC 4715 ADHESIVE (408)

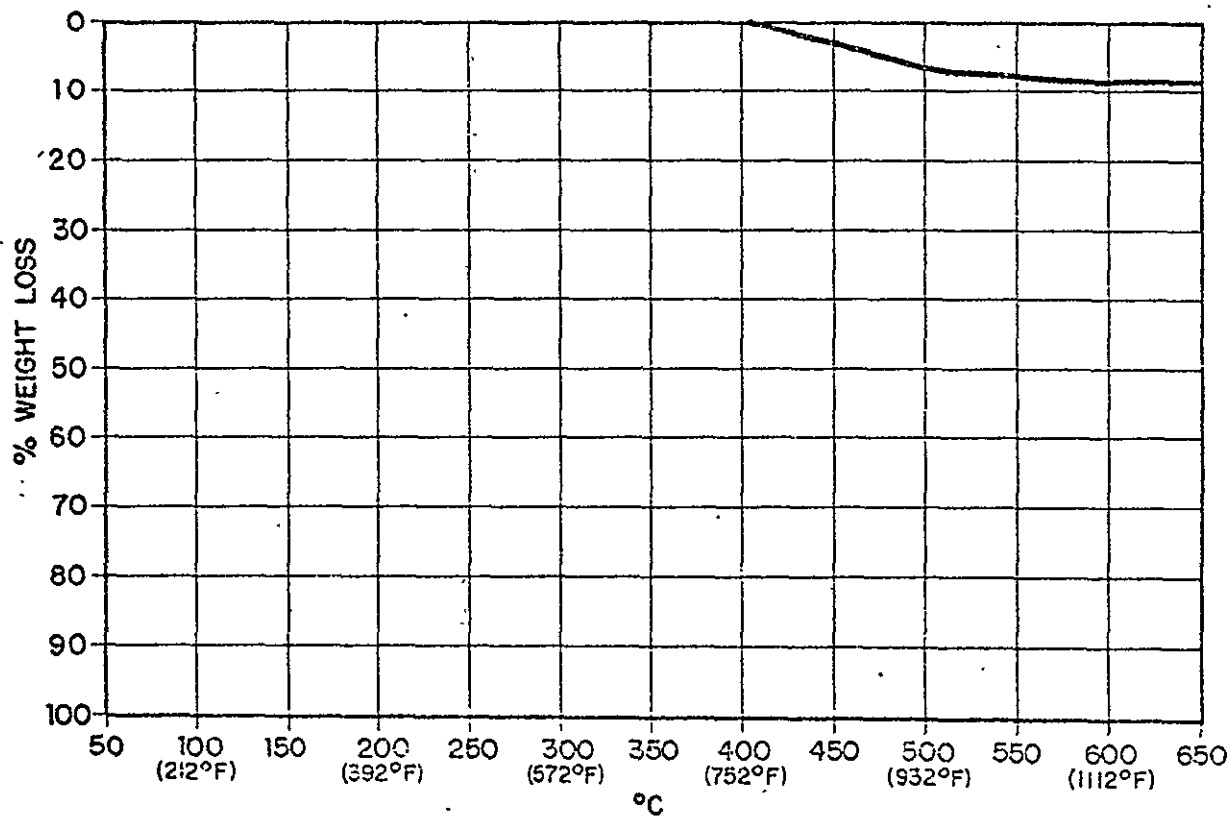


FIGURE 5. TGA CURVE - RTV 133 ADHESIVE (409)

ADHESIVE		TIME TO INCAPACITATION		TIME TO DEATH
RTV - 133	1.5g	6.4 $\pm$ 2	Range 4.5 9.1	2/6 lived 30 minutes aging trend not noticed
R-2332 N/F ADH.	0.25g	5 $\pm$ 2.6	Range 1.5 7.1	4/4 lived 30 minutes gets better with time
685 N/F Col. Cement	0.15g	1.8 4.9 0	Aging improves mate	1 died, 30 minutes 2/3 lived
EC4715 3M Co.	0.5g	5.1 $\pm$ 2.75 Range 2.4	7.9	1/3 lived 30 minutes aging effect noticeable
RI275 N/F Col. Cement	0.25g	13.1 $\pm$ 3	Range 6.5 10.2	1/3 lived 30 minutes No aging improvement noticeable.

TOXICITY TESTS - ADHESIVES
TABLE IV

MATERIAL		TIME TO FIRST SMOKE MIN.	SAMPLE PYROLYSIS TEMP. AT 1 st . SMOKE	FLASH RESPONSE				OBSERVATIONS
NO.	IDENTIFICATION & WT.			NO.	TIME MIN.	THERMAL PULSE HT. - DIVNS	SPL TEMP	
407	Adhesive R2332 N/F Columbia Cement #3 0.27g	0.56	414				No Flash	Yellowish Dense Smoke
405	Adhesive 685 0.28g	0.72	355	1 st . 2 nd .	2.00 2.16	4 16	614 650	Yellowish Dense Smoke Very Small Flash No Sound
	108 FRA Urethane Foam Paramount Indust. 0.52g	0.88	521	1 st . 2 nd .	1.04 2.16	91 75	567 739	1. Long Flame Travel (Yellow Dense Smoke 2. Med. Flame Travel (
408	Adhesive EC4715 (Black) 0.26g	0.72	367	1 st .	1.04	80	497	White Light Smoke Flash from Bottom to
406	Adhesive RI275 NF 0.27g	0.32	367				No Flash	Yellow/Gray Smoke Dense Smoke

FLASH FIRE PROPENSITY TEST

TABLE V

3.4 Joining Textile Materials

An area of concern has been the thermal resistance of sewn seams for textile materials when exposed to a thermal threat. A related supporting program conducted by Dr. Iosoro and staff at M.I.T. identified fiberglass thread coated with teflon R-753-18 and a single felled seam with three stitches as showing excellent thermal resistance to a fire threat. (Reference 4).

3.5 Multilayer Tests - Part 1

Part 1 multilayer specimen tests were conducted on a variety of upper layers that included: Decorative, Slip Cover and Fire Blocking Layers. These were combined with a glass fiber block cushion that was anticipated to contribute a minimum heat release to the total and therefore the least interference with data from the upper layers being evaluated.

These specimens were run at 3.5 w/cm^2 heat flux level (approximate block body temperature, 616°C or 1140°F.) since a higher flux (5 w/cm^2 or above) would compress the events in the burning profiles and obscure significant differences in response. This would complicate the task of detecting and evaluating any desirable subtractive effects or undesirable additive effects in terms of fire resistance that relate to the materials combinations used in the cushion layups. The 3.5 w/cm^2 Radiant Heat Flux was considered to be considerably higher in Thermal Threat level than any small ignition source.

The visually observed events were readily correlated with the smoke and heat release rate curves recorded by the HRR calorimeter instrumentation. The Heat Release Rate specimen configuration can be found in Appendix I-6.

3.6 Multilayer Tests - Part 2

Two upper layer groups were selected from Part 1 testing for use in Part 2 testing. The one group consisted of the following layers:

Decorative - 20787 Kermel/Wool (101)

Slip Cover - Nomex III (214)

Fire Block - 400-11 Durette Needle Punch Batt (216)

The other group consisted of the following layers:

Decorative - 20787 Kermel/Wool (101)

Slipcover/Fire Block - Vonar #3 with cotton scrim (210)

These groups of upper layers were tested in combination with a wide range of cushioning materials to test potential multilayer seat constructions for heat release. The test method was the same as used in Part 1 multilayer tests. Two specimens 20 and 21 were run at 1.5 w/cm^2 heat flux to determine the influence of lower heat fluxes on heat release rate.

4.0 MATERIALS DATA EVALUATION

It must be recognized that material selections for new fire resistant seat designs cannot be made independent of design but instead they must compliment each other in a manner to maximize fire resistance while meeting design performance requirements. The overall Phase I and Phase II programs have systematically selected out improved fire resistant materials for testing in each subsequent phase. The materials selected for multilayer testing all demonstrated superior fire resistant characteristics as compared to baseline materials. Therefore, other factors, including cost, producibility and availability will have a significant influence on the material selection process for the design and manufacture of full scale production seats.

4.1 Multilayer Tests - Part 1

Part 1 multilayer tests were conducted to evaluate the upper seat layers which receive initial exposure during the first five minutes of exposure. The use of glass block cushioning which was expected to contribute least to total heat release provided a standard cushion configuration that would not obscure the data for the upper layers. The detailed construction of Part 1 multilayer (ML) specimens (1-9) plus baseline (Specimen 10) is shown in Appendix I. The difference in thermo couple readings between the front and back face at the fire blocking layer indicate the delay provided by the insulation of this layer, which was its chief function. See Figure 6.

All of the specimens containing the fiberglass block cushion materials, with some variation showed initial, short term flaming, followed by a short period of non-flaming, and a second flaming event extending for several minutes as deeper layers of materials became involved.

The variations noted, and particularly the great differences in the smoke release rates are most probably indicative of the quantities and types of adhesives used, since most of the fabrics and battings are lower smoke producers. The baseline specimens 10, 11, and 20 burned rapidly and completely in the first few minutes.

The heat release at upper layers during the first five minutes as shown in Figure 7 was fairly comparable. After five minutes the fire blocking layer and adhesive from the cushion became involved and significant differences could be observed. All of the specimens gave a lower total heat release than the baseline specimen. The heat release of the baseline (10) in the first 1.5 minutes was over twice that of the nearest ML specimens. This rapid heat rise in the first minute and a half is indicative of a potentially hazardous contribution toward fire spread and should be avoided in selecting materials. The upper layers identified in ML specimens 5 and 8 were selected for Part II testing in which various cushion materials were to be tested with the selected upper layers. The very high heat release associated with the silicone foam as well as the baseline urethane suggests a limited use in terms of total mass for these materials.

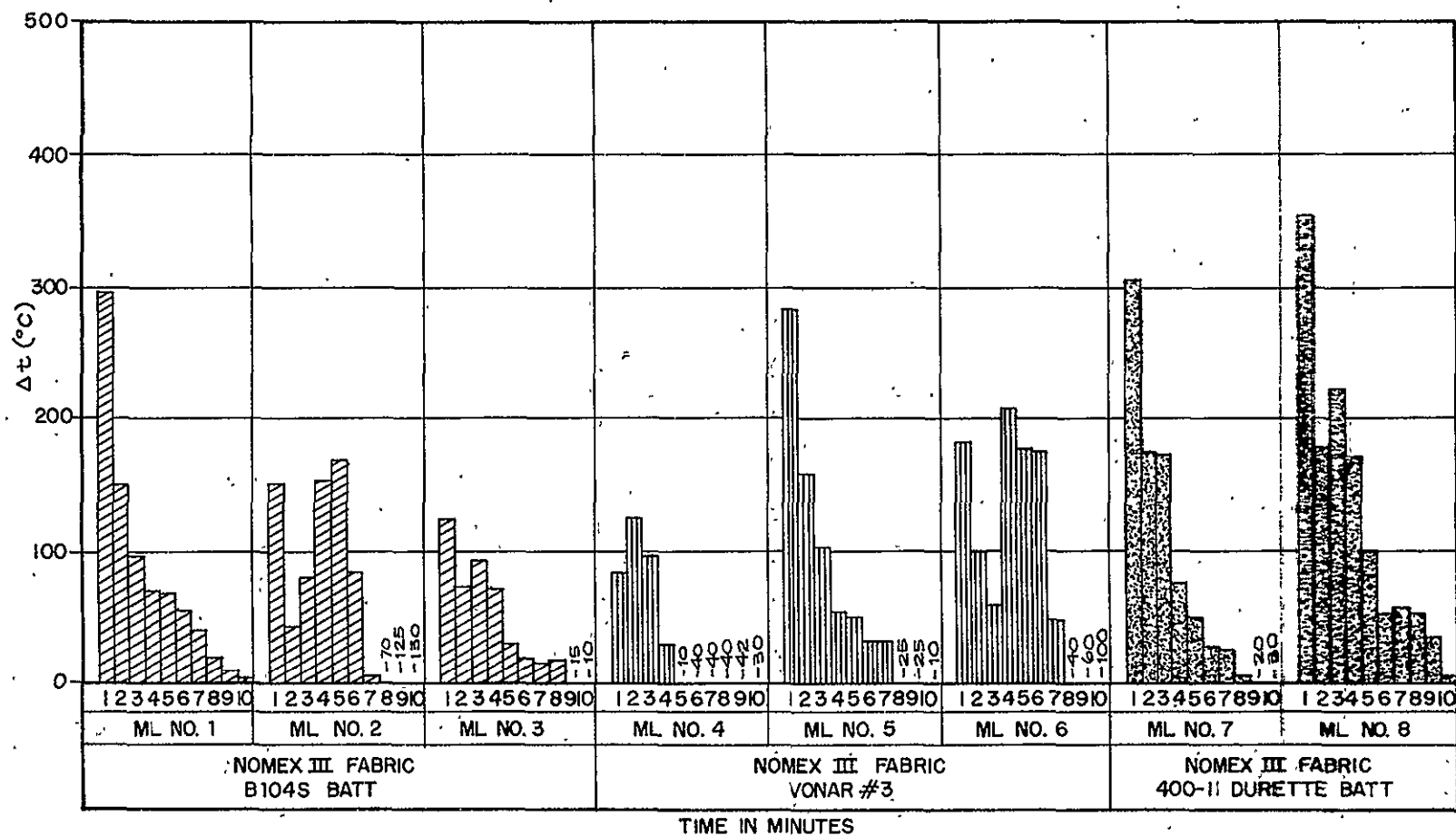


FIGURE 6. Δt (°C) FRONT -BACKFACE - FIRE BLOCKING LAYER

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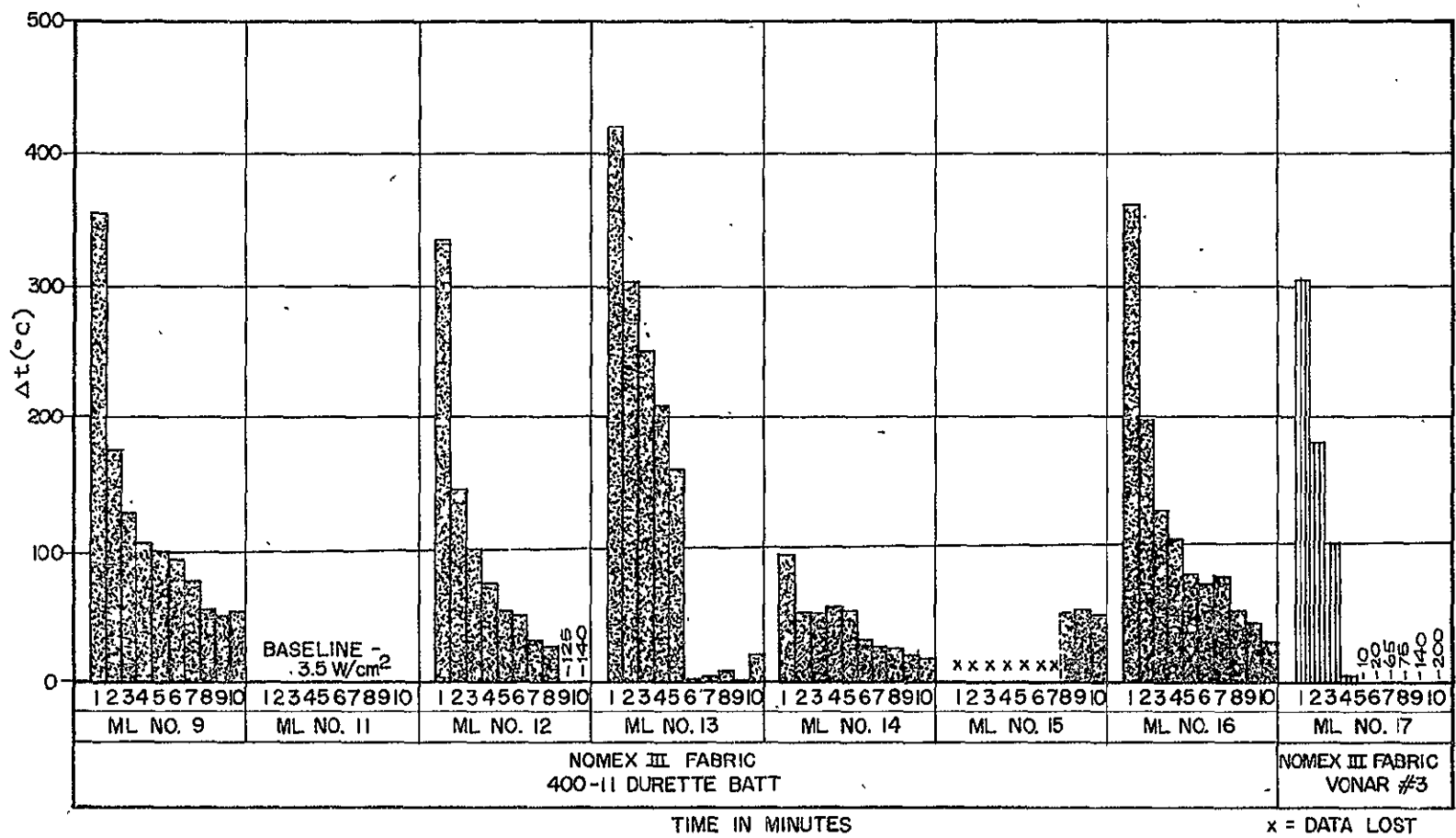


FIGURE 6 (CONT'D) Δt(°C) FRONT -BACKFACE - FIRE BLOCKING LAYER

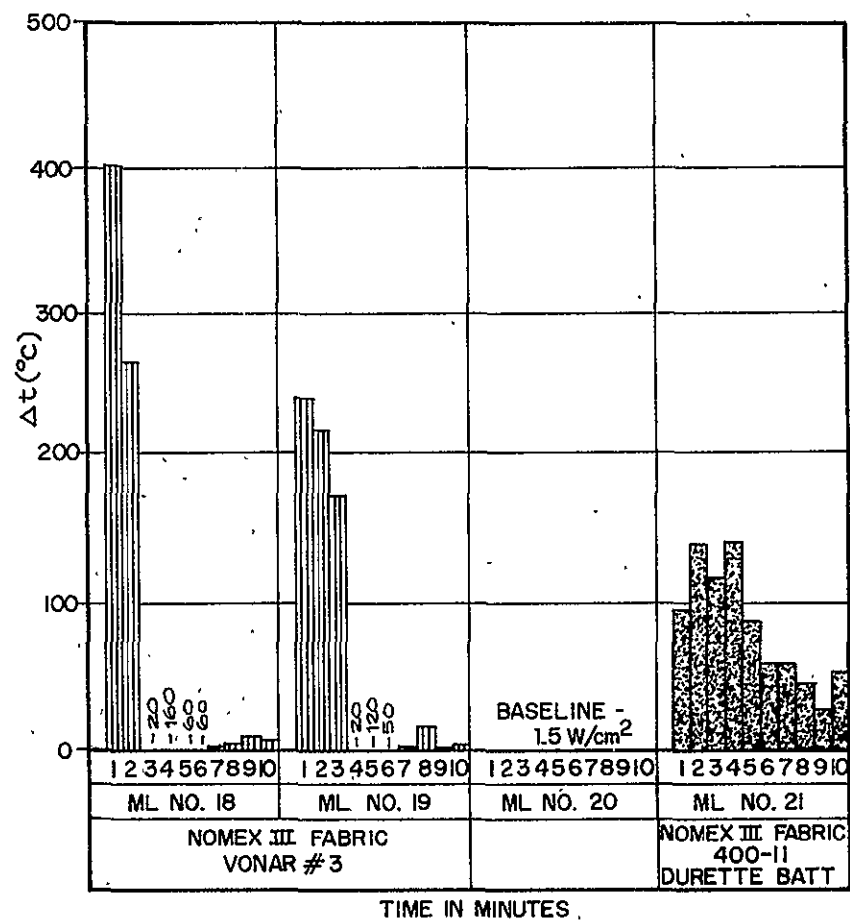


FIGURE 6. (CONT'D) Δt (°C) FRONT -BACKFACE - FIRE BLOCKING LAYER

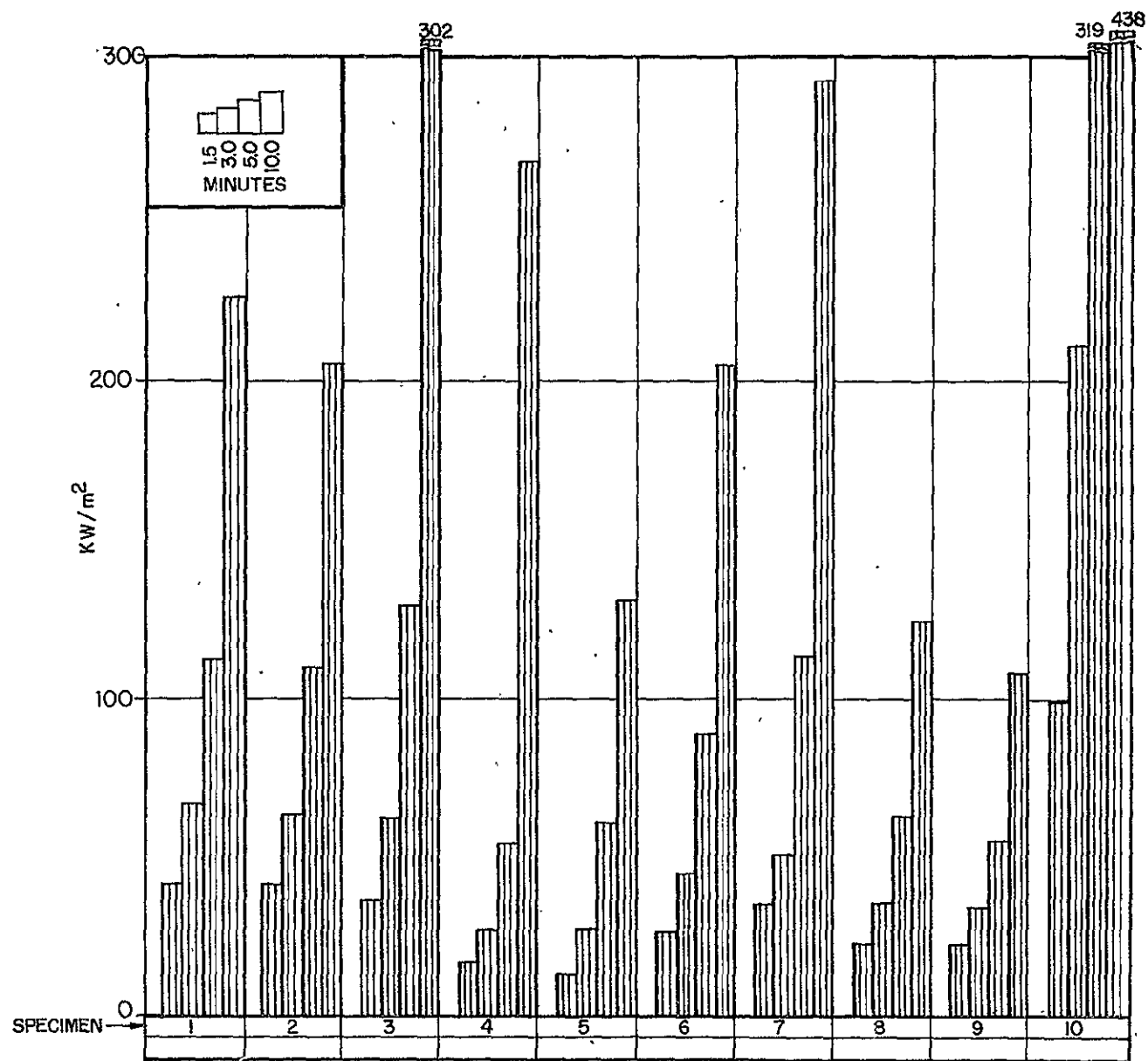


FIGURE 7. PART 1 HRR - MULTILAYER SPECIMENS - 3.5 W/cm²

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4.2 Multilayer Tests - Part 2

The Part 2 ML specimen tests incorporated the upper layers selected from Part 1 except for ML specimen 21 (tested at 1.5 w/cm^2) which incorporated a layer of heat stable PBI (222) that was received late in the program. For detailed ML specimen construction see Appendix I-6. All other Part 2 ML specimens were tested at 3.5 w/cm^2 . Results are shown in Figure 8. The heat release during the first 5 minutes of exposure showed good confirmation for the same groups of upper layers from specimen to specimen. One upper layer group was the Decorative 20787 Kermel/Wool (101) Nomex III (214) slip-cover and Durette 400-11 (216) fire blocking layer (12 through 16 and 8). The other upper layer group was Decorative 20787 (101) and Vonar 3 with scrim (210) specimens (17 through 19 and 5).

The smoke generation shown in Figure 9 for Part 2 tests showed good confirmation during the first five minutes for each upper layer group. The neoprene and glass cushion specimens were outstanding. Except for the silicone cushion material ML specimens, the other specimens displayed low heat release and tended to show differences less than 50 kw/m^2 . The polyimide foam that was tested had a very low density 0.5 lbs/ft^3 and from a mechanical standpoint probably was inadequate. If a higher density becomes available it may generate significantly more heat due to the increase in mass.

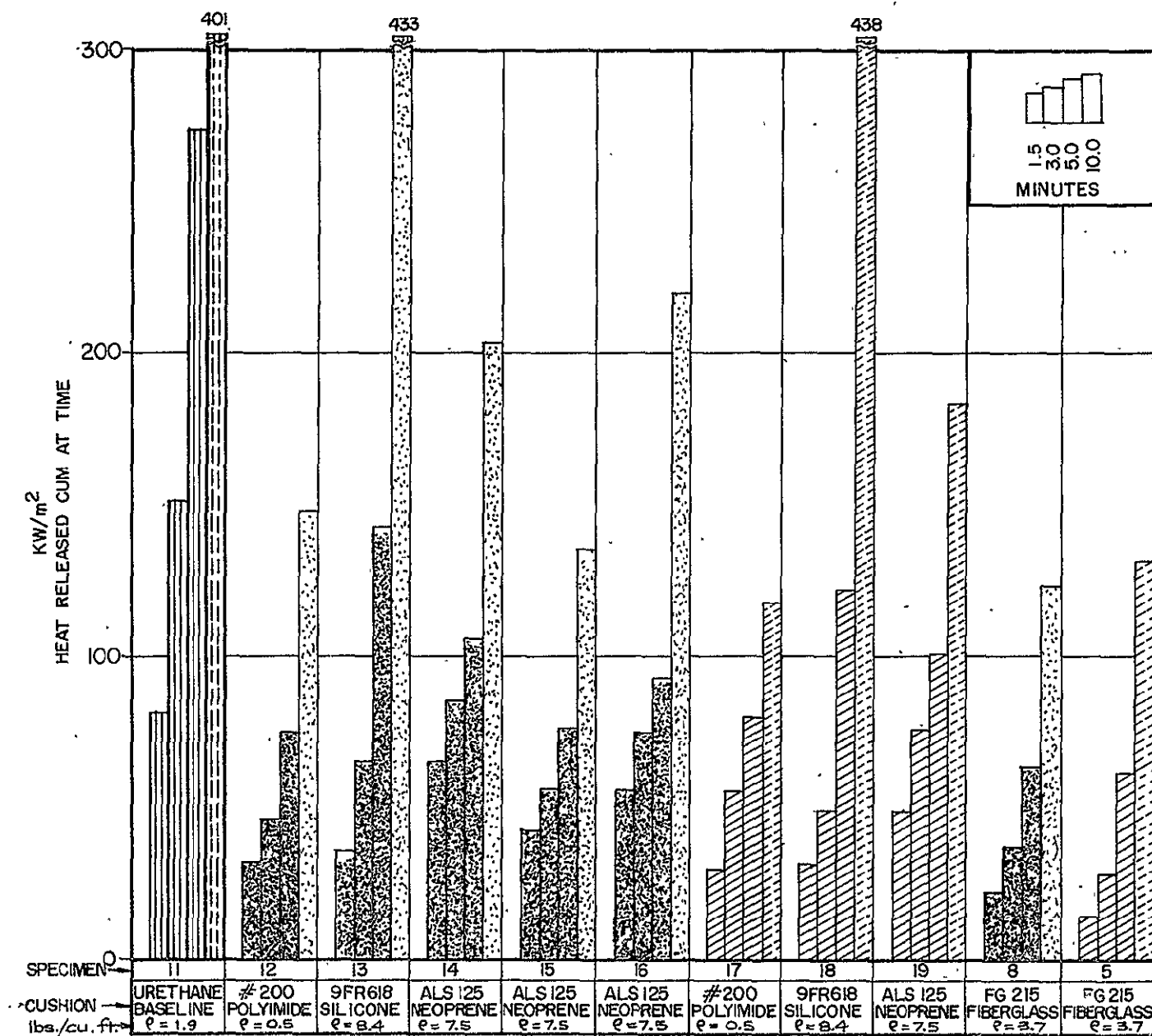
One of the concerns in the program has been the effect of material when used as a multilayer construction as compared to individual thermal resistivity. Figure 10 shows the effect of combined materials from Phase II testing. The upper layers were grouped and individual HRRs totaled and shown in the lower light part of the bar. The cushion layer HRR was shown as the upper part of the light bar. The black bar shows the total HRR from ML test results. Fortunately, the combined effect produces less heat than the sum of the individual layers. The difference is primarily due to insulation provided by the upper layers, char formation and blocking of combustion gases from the burning surface.

Table VI shows the comparison of testing almost identical multilayer constructions at 1.5 w/cm^2 vs. 3.5 w/cm^2 . The improvement in the newer type of multiple layer construction (21) is obvious. No. 21 did not flame, even though piloted ignition was used, while No. 20 burned completely.

These results focus attention on the importance of the scenario and related thermal flux conditions. The thermal flux has a significant impact on the heat release rate of exposed materials. If the full scale seats perform in a comparable manner to the multilayer specimens in a full scale fire the utility of this type of test in setting standards of performance will be enhanced.

4.2.1 Data Analysis Summary

All multilayer specimens showed total heat release below 125 KW/in^2 for the first five minutes of exposure. Only the silicone foam tested and urethane baseline material showed heat release for multilayer specimens above 300 KW/m^2 for ten minutes of exposure. All other material showed a superiority over the baseline materials. A significant delay in heat release was obtained by use of a fire blocking layer. Significantly less heat was generated during a ten minute period at 1.5 w/cm^2 heat flux compared to 3.5 w/cm^2 . Modifications of materials or selection of different weave, weight or mass will significantly affect the performance of the material in terms of heat release.

FIGURE 8. PART 2 HRR - MULTILAYER SPECIMENS - 3.5 W/cm²

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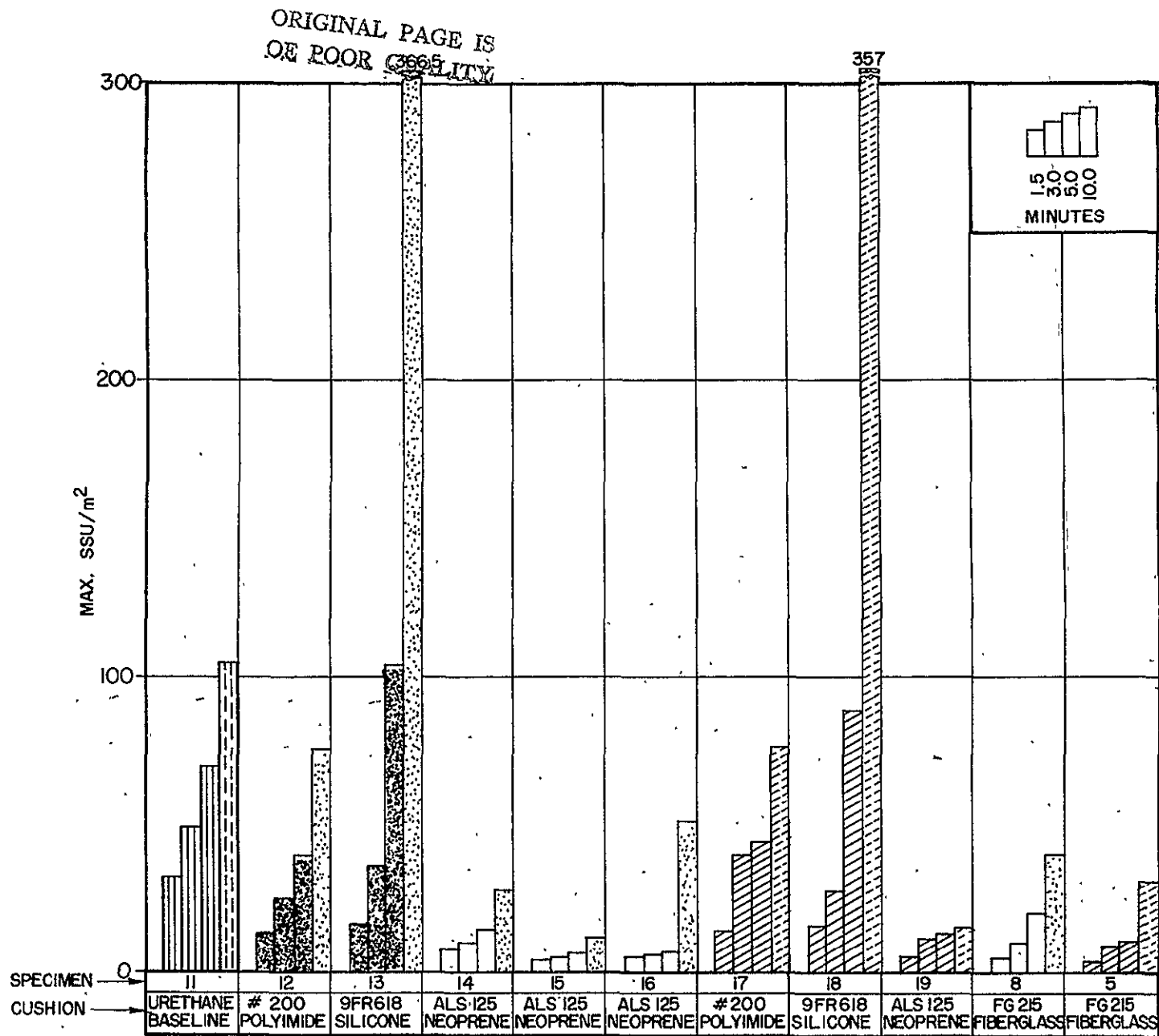
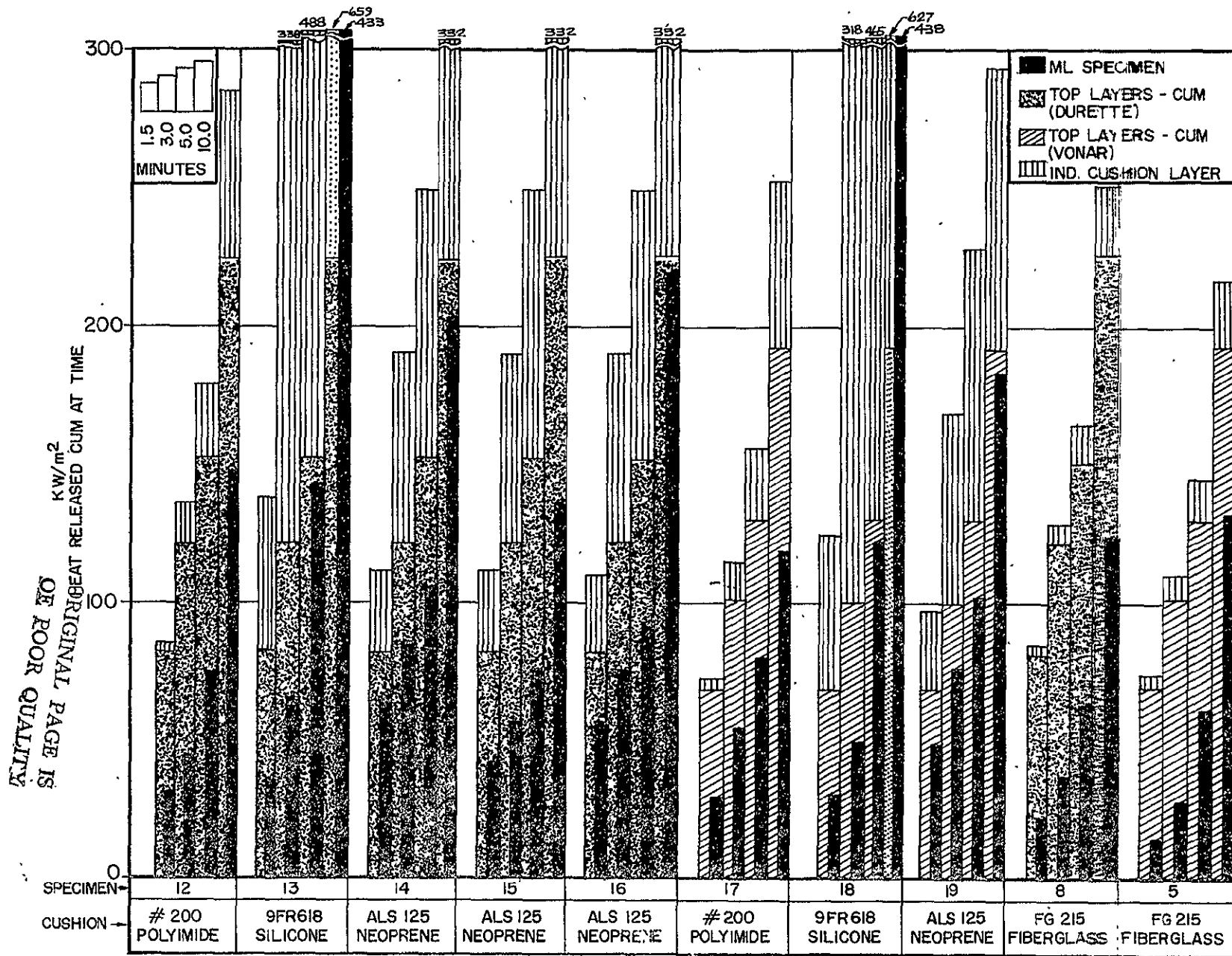


FIGURE 9. PART 2 HRR - MULTILAYER SPECIMENS - 3.5 W/cm² SMOKE GEN

FIGURE 10. PART 2 HRR - MULTILAYER SPECIMENS - 3.5 W/cm²

TIME OF EXPOSURE	HEAT FLUX		HEAT FLUX	
	1.5	3.5	1.5	3.5
1.5 Min	25.7	99	3.7	56.9
3 Min	57.6	212	10.5	74.1
5 Min	72.1	319	14.6	93.2
10 Min	---	438	28.3	220
SPECIMEN NO.	20	10	21	16
DESCRIPTION OF LAYERS				
Decorative	(104)	(104)	(101)	(101)
Slip Cover	Cotton	Cotton	(214)	(214)
Fire Block	-	-	(216)	(216)
Reinforcement	-	-	(222)	(214)
Cushion	(306)	(306)	(310)	(310)

THERMAL FLUX - HEAT RELEASE
TABLE VI

4.3 Economic Analysis

Estimated material costs available for the materials tested in Phase II are summarized in Table VII. Material costs represent only a small part of the total potential costs associated with seat materials. The labor or processing costs which cannot be established without design of the seat, is likely to be far more significant. However, the interdependency of material selection, design and process is well established and any new designs should be evaluated as a total system including the relationship to the level of performance in a thermal threat and potential in service durability and suitability.

COST 1978 ESTIMATED	(101) 20787 Kermel/Wool Blend H. LeLievve	(203) B104S Needle Punch Batt AKI	(210) Vomar #3 Interliner DuPont	MATERIAL (213) SE55559 Silicone Elastomer G.E.	(214) Nomex III Southern Milk	(216) 400-11 Durette Needle Punch	(217) 400-6 Durette Fabric Fire Safe Prod.	(222) 40-9031-2 PBI Celanese
Cost \$/yd ² @ 500 yds ²	7.35	2.27	1.66	--	5.42	12.25		--
Cost \$/yd ² @ 2000 yds ²	7.35	2.17	1.66	--	5.42	11.00		--
COST 1978 ESTIMATED	(300) FG 215 Fiberglass Block Expanded Rubber	(309) 9FR618 Silicone Foam Kirkhill	(310) ALS 125 Neoprene Toyad	MATERIAL (315) #200 Polyimide Solar	(407) 2332N/F Adhesive Columbia Cement	(409) RTV133 Sealant G.E.		
Cost \$/ft ³ 1000 lbs.	9.90	64.39	13.12	--				
Cost \$/ft ³	9.50	62.70	13.12	--				

MATERIAL COSTS
TABLE VII

5.0 DEVELOPMENT OF A FULL SCALE STANDARD FIRE SOURCE

5.0.1 Scope

This section describes the work accomplished to satisfy the following program subtasks.

- o Establish likely or reasonable fire threat levels that an aircraft passenger seat would be subjected to in an on-board fire situation.
- o Develop a repeatable fire source representative of an on-board fire situation within the Cabin Fire Simulator (CFS) and ascertain the thermal characteristics thereof.

5.1 Establishing a Fire Threat Level

5.1.1 Purpose

The purpose of this study was to determine the fire threat level that could result from probable on-board fire sources.

5.1.2 In Service Aircraft Survey

To establish likely and reasonable fire threat levels a survey of in-service aircraft was conducted by engineering personnel. On the night of 2-23-78 of in-service aircraft, three aircraft were surveyed; one from a short flight (Houston to Los Angeles); one from a medium length flight (Chicago to Los Angeles); and one from a long flight (London to Los Angeles). The aircraft cabin was surveyed prior to cleaning in order to obtain a representative picture of the aircraft condition. Pictures of the cabin were taken as well as representative samples of on-board items of clutter. Each condition that was photographed was identified by the location of the seat in the aircraft, date and time of the survey, aircraft type, originating city of the flight and the location of the clutter with respect to the seat. Photographs of the aircraft's condition are presented as Figures 11 through 21.

Six bags of trash were collected, which was believed to be representative of the trash onboard the aircraft. The items in each bag were then itemized and weighed. See Table VIII. Since newspaper was the predominant item onboard the aircraft, it was decided this was a likely fire threat and should be tested to establish a standard fire. Also, it was decided on the basis of the average weight that 1.50 pounds of newspaper would be representative of the weight of one newspaper which would be commonly found on an aircraft. It will be noted from the pictures that the majority of the trash was found in the pockets on the back of the seats. This was mainly cocktail napkins, small plastic bags, cigarette wrappings and packs and the typical airline magazine, emergency card and air sickness bag. Each pocket is held closed by an elastic cord which holds the contents of the pocket in a tightly packed configuration. It is believed that if a fire were to start in the seat pocket it would not propagate beyond the seat due to the compaction and the small amount of material in the pocket.

During the survey, it was observed that not a great deal of trash was prevalent on any of the aircraft surveyed, however as noted earlier newspaper was observed in many locations.

It is believed that the survey was a good cross sampling and the items found would be representative of any inflight aircraft. Using the data obtained from this survey, the program was continued to establish a "standard fire source", to be used for subsequent full scale seat burn tests.

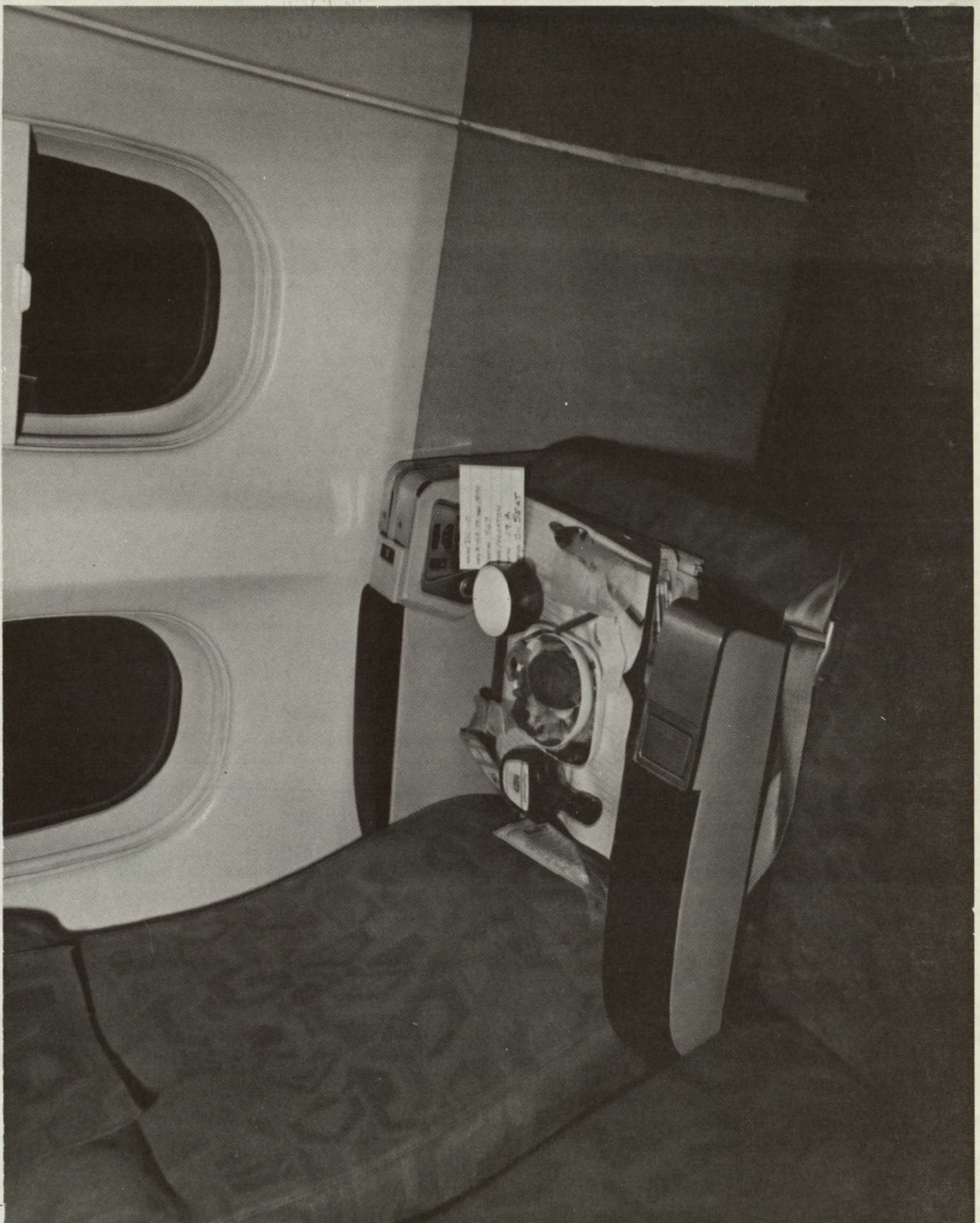


FIGURE 11. AIRCRAFT CONDITION - HOUSTON TO LOS ANGELES

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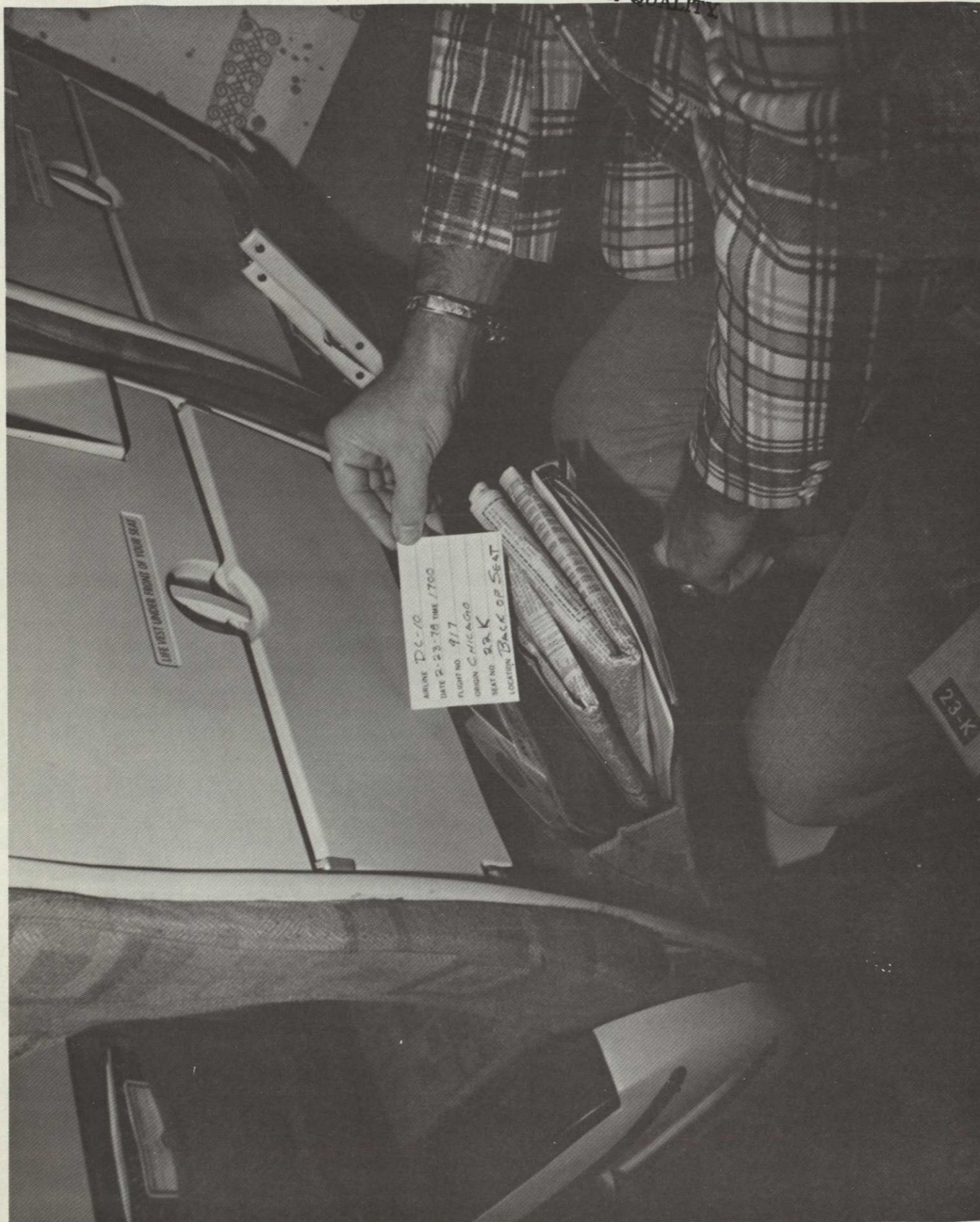


FIGURE 12. AIRCRAFT CONDITION - CHICAGO TO LOS ANGELES

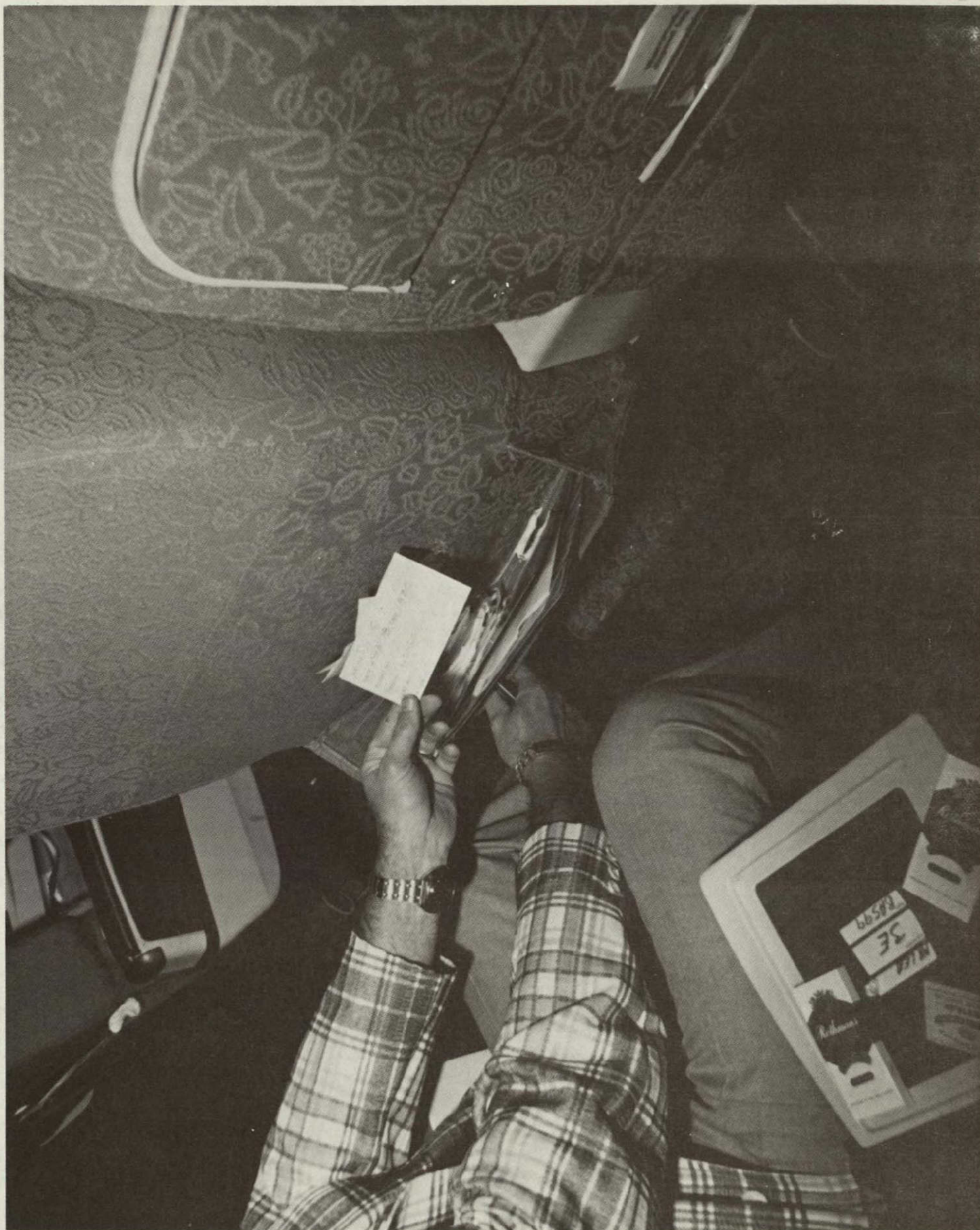


FIGURE 13. AIRCRAFT CONDITION - LONDON TO LOS ANGELES

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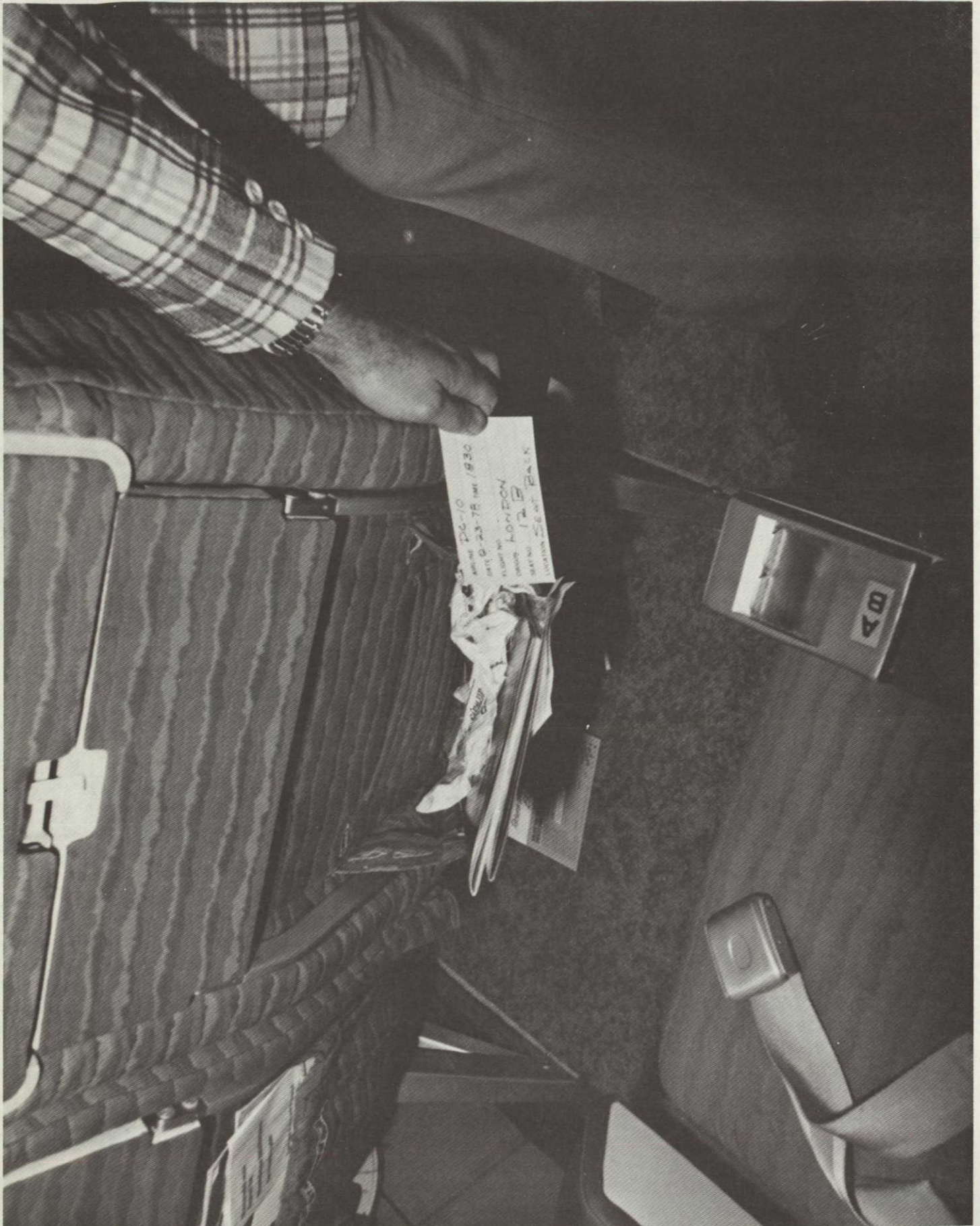


FIGURE 14. AIRCRAFT CONDITION - LONDON TO LOS ANGELES

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FIGURE 15. AIRCRAFT CONDITION - HOUSTON TO LOS ANGELES

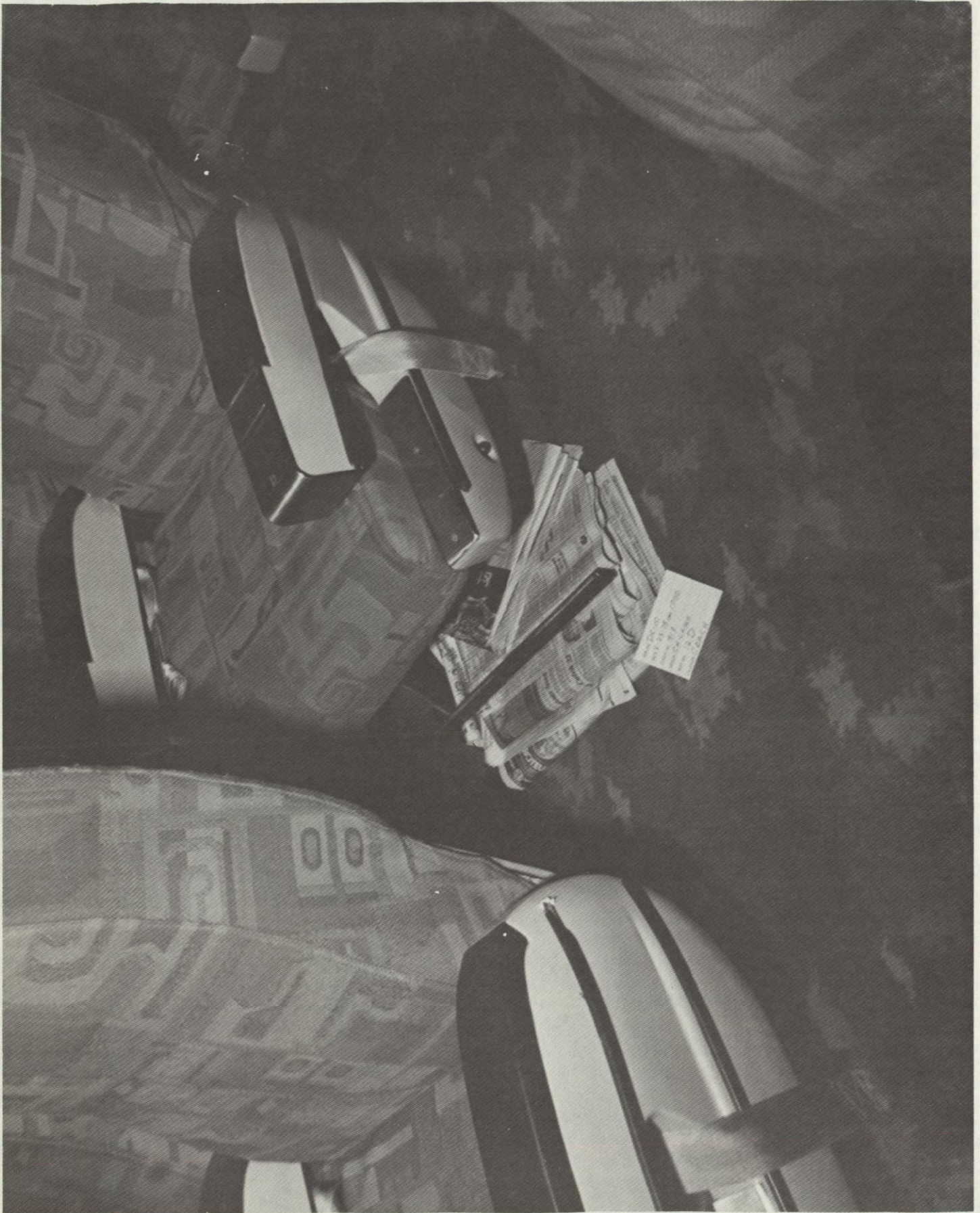


FIGURE 16. AIRCRAFT CONDITION - CHICAGO TO LOS ANGELES



FIGURE 17. AIRCRAFT CONDITION - CHICATO TO LOS ANGELES

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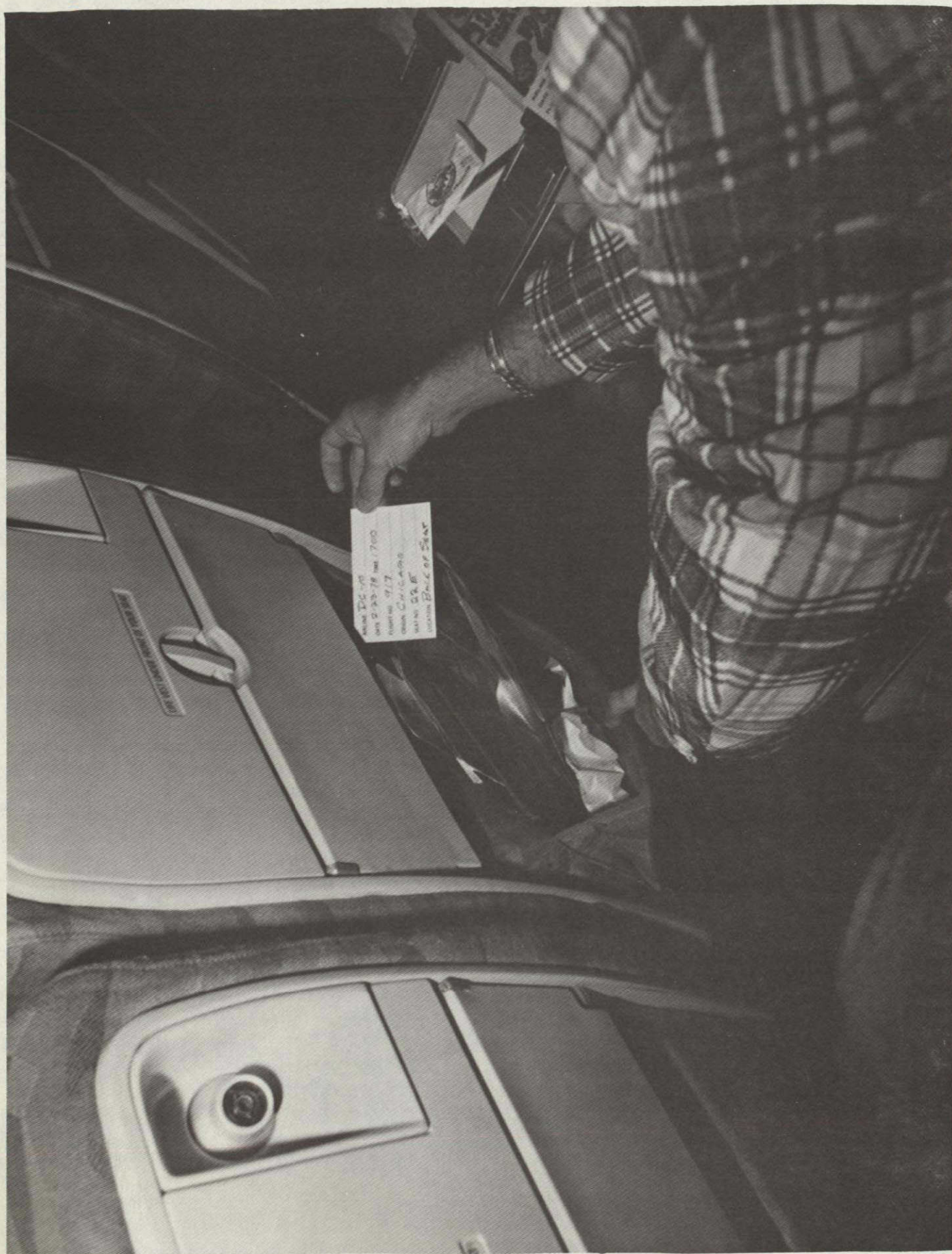
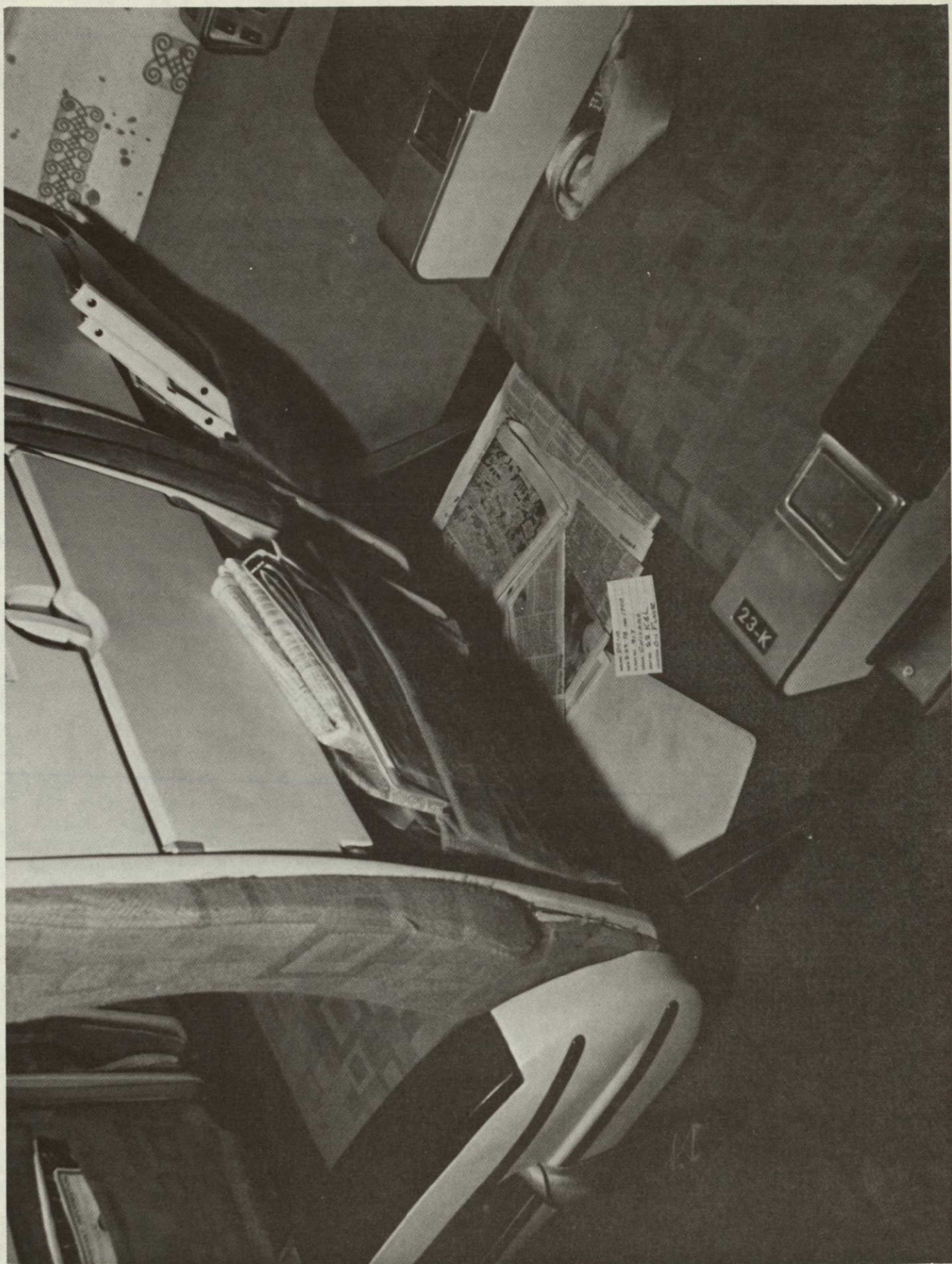


FIGURE 18. AIRCRAFT CONDITION - CHICAGO TO LOS ANGELES



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FIGURE 19. AIRCRAFT CONDITION - CHICAGO TO LOS ANGELES



FIGURE 20. AIRCRAFT CONDITION - HOUSTON TO LOS ANGELES

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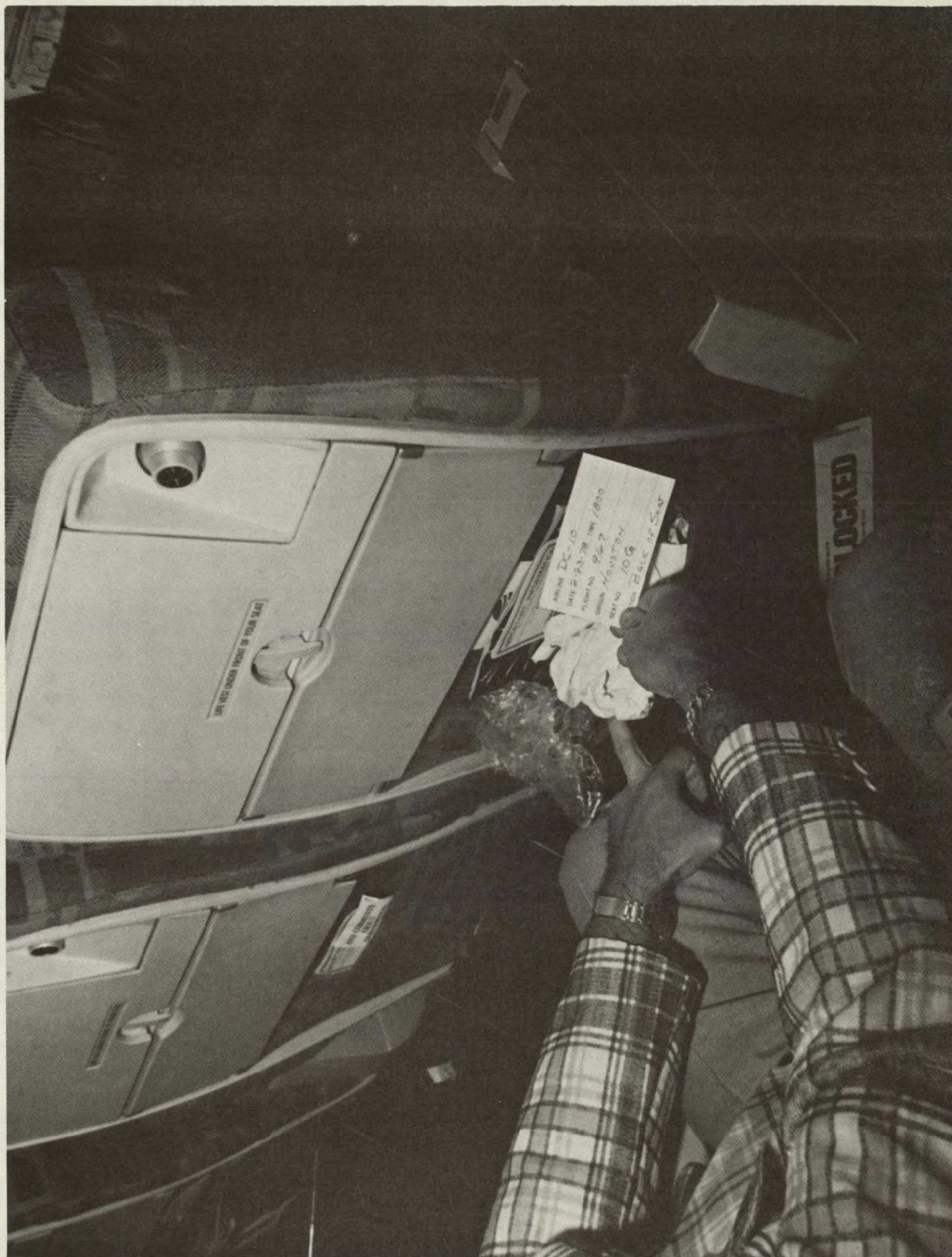


FIGURE 21. AIRCRAFT CONDITION - HOUSTON TO LOS ANGELES

AIRPLANE: DC-10

DATE: 2-23-78

	BAG 1	BAG 2	BAG 3	BAG 4	BAG 5	BAG 6
AIRCRAFT ORIGIN	CHICAGO	CHICAGO	CHICAGO	LONDON	LONDON	LONDON
SEAT NO./LOCATION	22K AND L/COACH	5K/FIRST CLASS	12D/COACH	UNKNOWN	12B/COACH	28F/COACH
LOCATION RELATIVE TO SEAT	ON FLOOR UNDER AND BEHIND SEAT	ON FLOOR BEHIND SEAT	ON FLOOR UNDER SEAT	UNKNOWN	IN POCKET ON BACK OF SEAT	ON FLOOR IN FRONT OF SEAT
ITEMS COLLECTED	NEWSPAPER - 7 SECTIONS AND ADS	HEADPHONE BAG USED CIGARETTE PACKS NEWSPAPER	2 NEWSPAPERS - ONE WITH SIX SECTIONS - ONE WITH FOUR SECTIONS	2 NEWSPAPERS	2 HEADSET BAGS 1 AIRSICK BAG 1 NAPKIN (COCKTAIL SIZE) 1 AIRLINE MAG	NEWSPAPER - 8 SECTIONS
WEIGHT OF ITEMS	1.44 POUNDS	1.50 POUNDS	2.15 POUNDS	1.52 POUNDS	0.45 POUNDS	1.25 POUNDS

AVERAGE WEIGHT OF ITEMS:
1.385 POUNDS

AIRLINE TRASH DATA
TABLE VIII

5.2 Standard Fire Determination

5.2.1 Purpose

This task of Phase II was limited to the development of a standard fire source which will be used during Phase III testing. The fire source to be developed was required to be a realistic repeatable, and representative of conditions found onboard an aircraft during flight. The previous aircraft survey established the fire threat to be used as the basis of this determination.

5.2.2 Test Article

The test article was a pre-1973 double passenger seat which had all of the cushions, padding and other organic material removed. The seat pan and back were fabricated from 0.015 stainless steel sheeting. This also provided a base for the fire and also a mounting surface for the thermocouples. The seat is shown in Figures 22 and 23.

5.2.3 Test Instrumentation

5.2.3.1 Photo Instrumentation

Color still photos were taken of the test set up, and before and after each test. The before and after photos of each test are presented in Appendix II. In addition to the still photos, color movies at 5 FPS were taken for each test. Finally closed circuit color TV coverage was provided for each test. The film and TV tapes are presented separately from this report.

5.2.3.2 Thermal Instrumentation

Data from each fire obtained by thermocouples welded onto the seat structure. See Figure 24 for typical installation. Two thermocouples and two Circular Foil Heat Flux Gages (Calorimeter), Thermogage Model 1000-1A were mounted on a bar, centered over and 18 inches above each seat bottom. (Figure 25). A pictorial representation of the seat showing the thermocouple and calorimeter location is shown as Figure 26. The thermocouple and calorimeter readings were fed into a PDP-10 Recording Computer which in turn fed a PDP-15 Printout Computer. The raw computer data was then plotted by the Data Reduction Center of MDAC, Huntington Beach, California. These plots are presented in Appendix III. The PDP 10 Computer was also programmed to supply 110 volt power to the electric wire igniter which was used to insure constant ignitor source for each test. Figure 27 shows the electric ignitor.

5.2.4 Test Conditions

The test conditions are shown in Table IX. These conditions were based on an analysis of the interior conditions which were surveyed on aircraft arriving at the Los Angeles Airport.

5.2.5 Test Set-up

The instrumented seat was positioned in the Cabin Fire Simulator (CFS) and readied for test. See Figure 28. Camera and TV boxes inside the CFS are shown in Figure 29. Wires from the camera and TV were run through the chamber wall to a video recorder and monitor outside of the chamber. See Figure 30. Newspaper or the radiant panel was positioned near or on the seat depending upon the condition to be tested. The radiant heat panel used for Tests 26, 27, 28 consisted of 14-500 watt, G.E. 500T3/CL/HT-115-125V, Quartz Infrared Lamps. These were positioned on a panel as shown in Figure 31. Power to drive the panel was provided by a R. I. Research Inc. Thermac Controller, Model TC 5192. This controller is shown in Figure 32.

5.2.6 Test Procedure

For Tests 1-25, newspaper was positioned on or near the seat in accord with the condition to be tested and an electrical ignitor was wrapped with tissue and placed on or under the paper. The chamber was closed and the cabin ventilating air (960 CFM) started. A 30-second countdown was then started with the camera and TV started at T-20 seconds. At T=0 the computer was started. At T+5 seconds the ignitor was automatically activated and remained on for 30 seconds. At the end of the 30-second period the computer shut off power to the ignitor and the fire allowed to burn by its own combustion. In each case, the paper ignited between 15 and 25 seconds after the ignitor was energized. For Tests 26, 27 and 28 the procedure was similar except the radiant panel was turned on at T=0. For each test, the computer was programmed to record data for 15 minutes, then terminate the recording of data, regardless of the condition of the fire. This was done so that a comparative analysis could be conducted between different fire conditions. Still photos were taken before and after each test. (See Appendix II).

5.2.7 Test Description

In this section, a brief description and results of each test will be given. The resulting curves are presented in Appendix III.

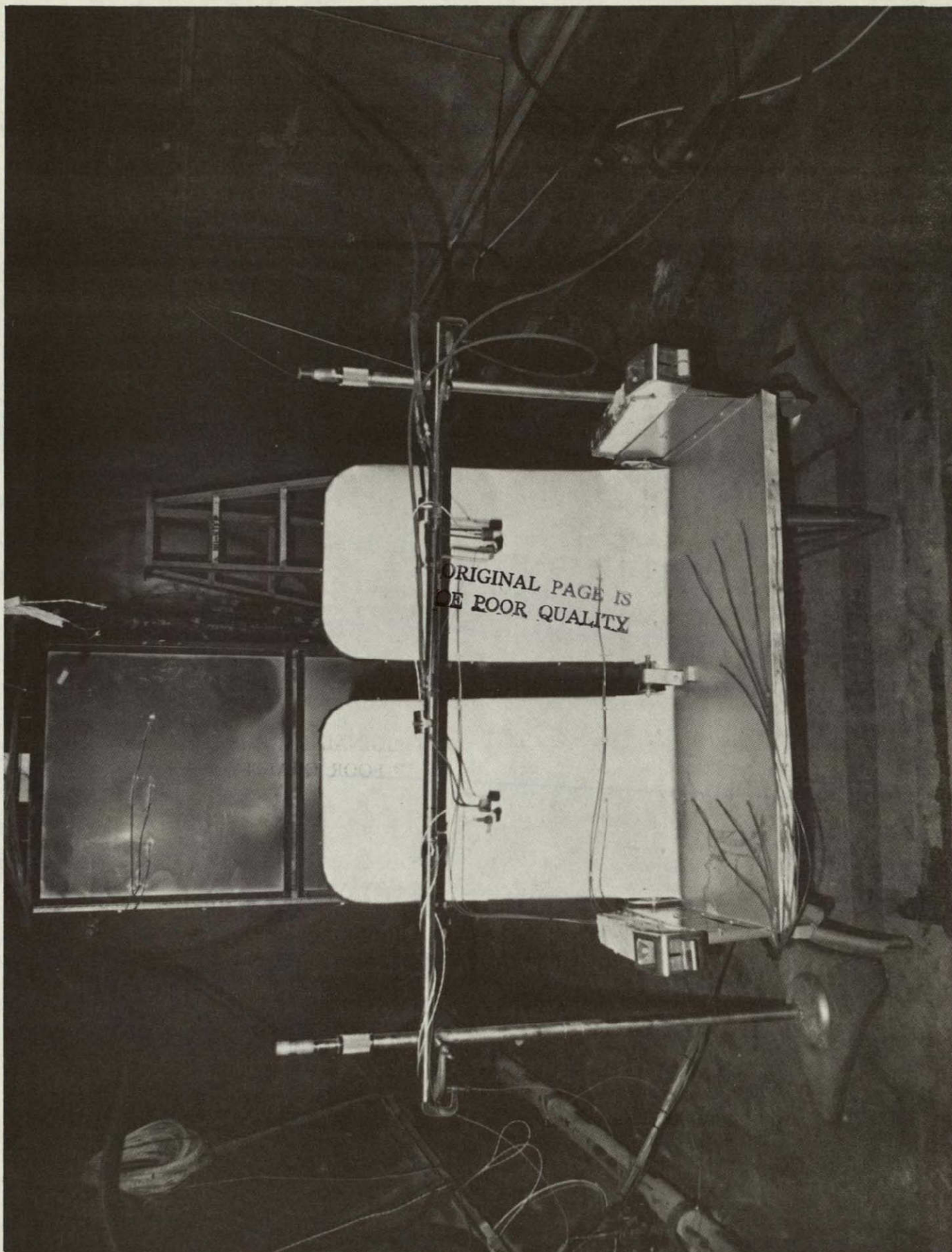


FIGURE 22. TEST ARTICLE (DOUBLE SEAT) - FRONT VIEW

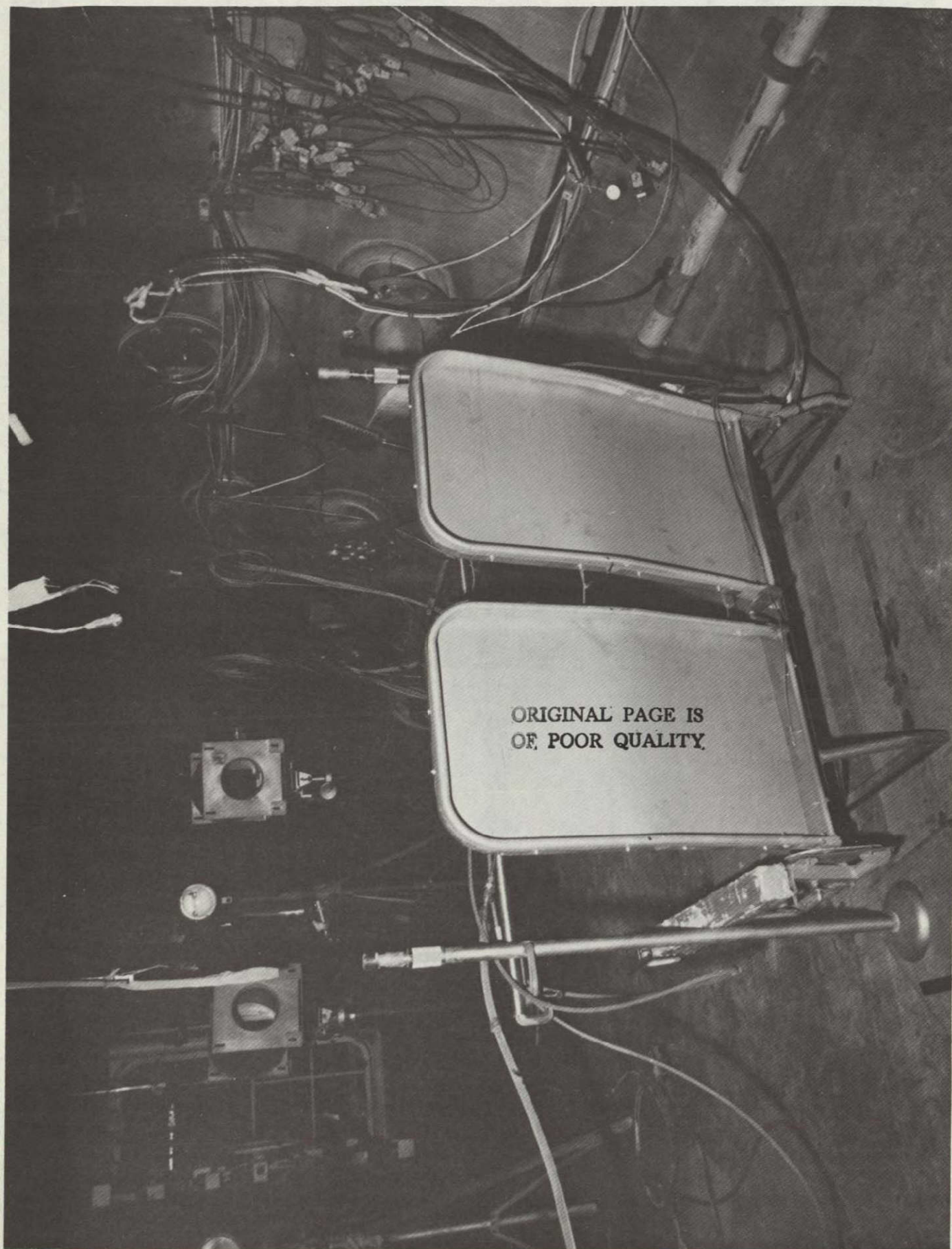


FIGURE 23. TEST ARTICLE (DOUBLE SEAT - REAR VIEW)

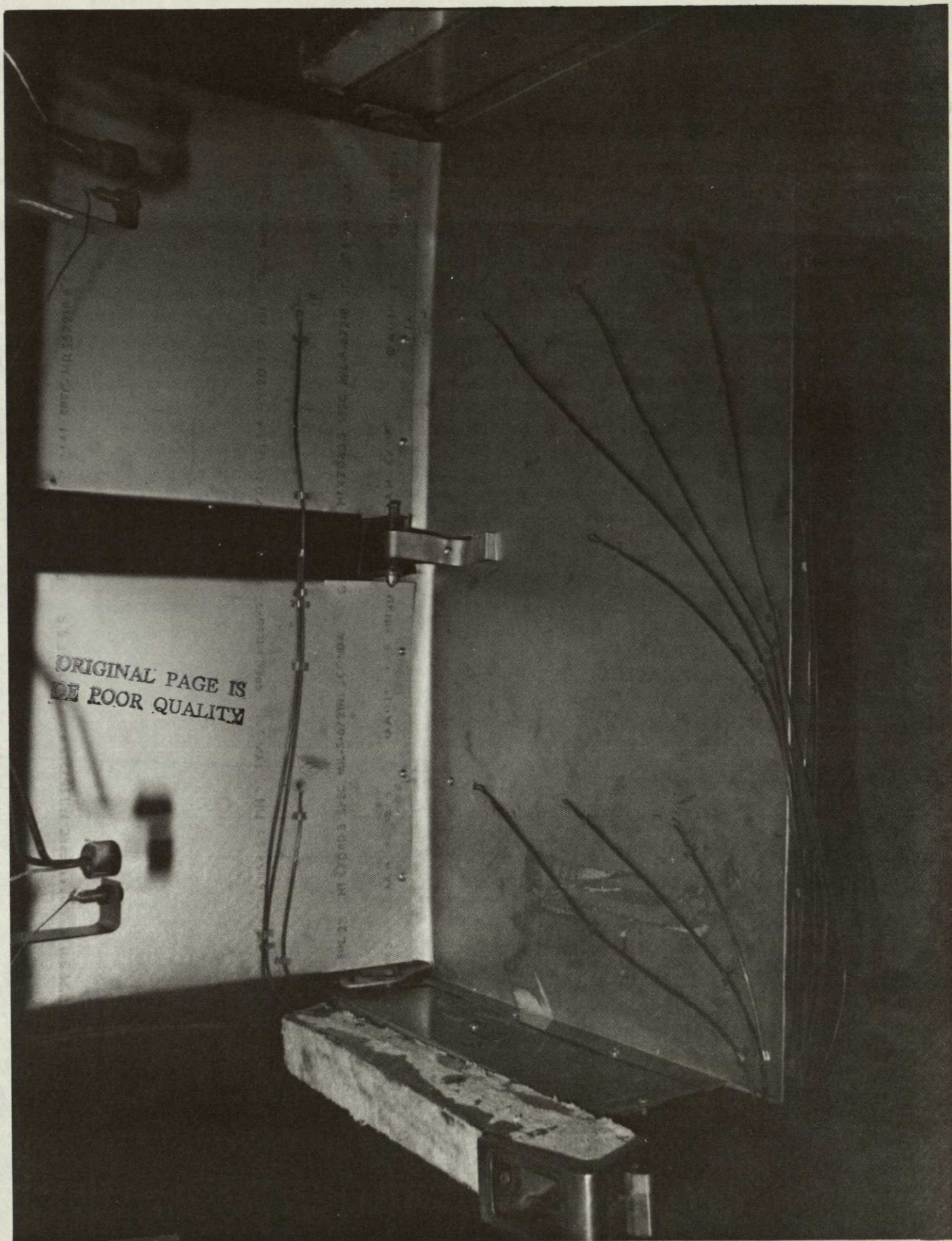


FIGURE 24. THERMOCOUPLE INSTALLATION

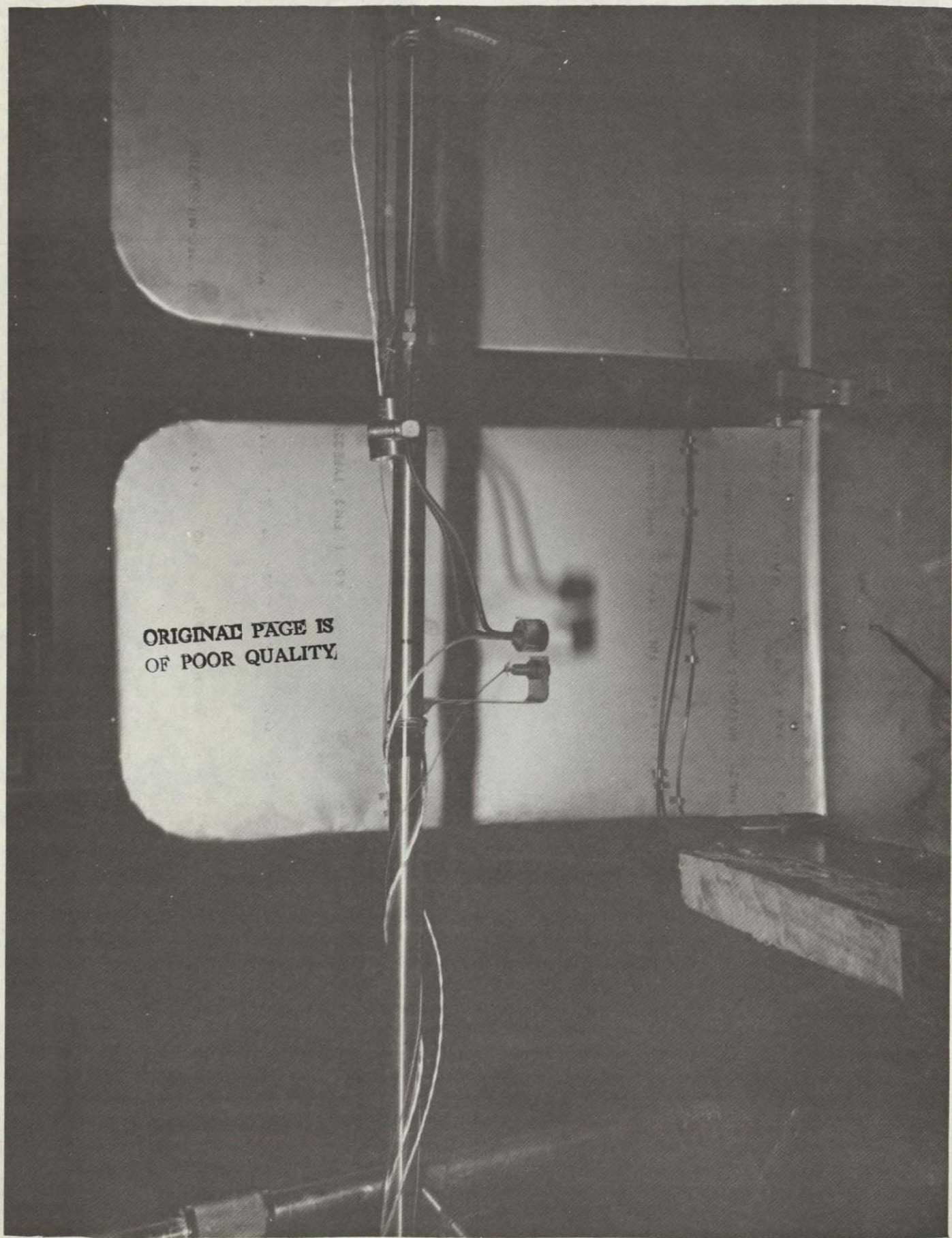


FIGURE 25. CALORIMETER INSTALLATION

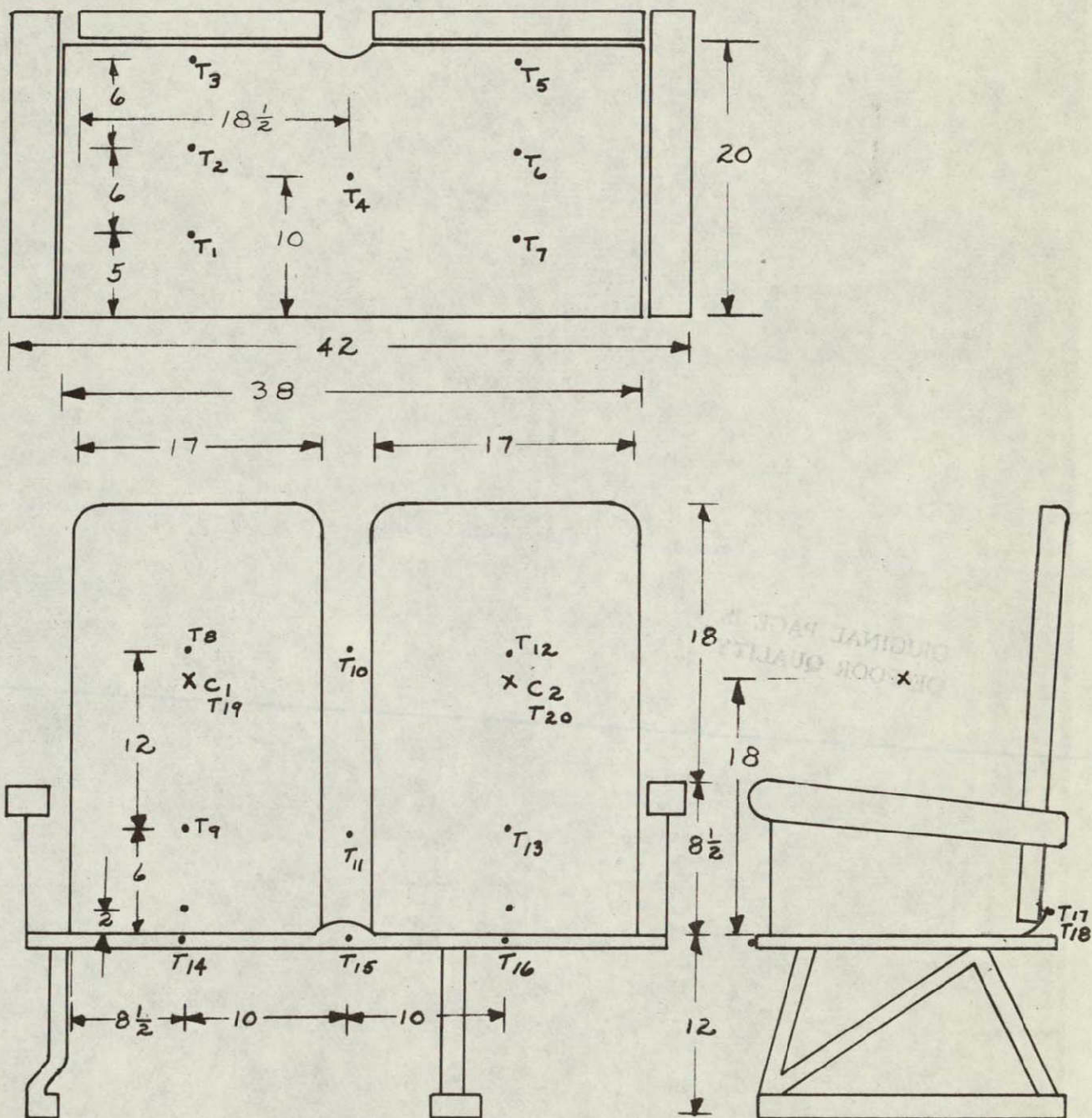


FIGURE 26. THERMOCOUPLE AND CALORIMETER LOCATIONS



FIGURE 27. ELECTRIC IGNITER

<u>TEST NO.</u>	<u>CATEGORY</u>	<u>TEST CONDITION</u>	<u>RUN NO.</u>
ST-1	I	1-1/2-POUND NEWSPAPER ON SEAT	1
ST-2	I		2
ST-3	I		3
ST-4	II	1-1/2-POUND NEWSPAPER ON FLOOR – FRONT OF SEAT	1
ST-5	II		2
ST-6	II		3
ST-7	III	1-1/2-POUND NEWSPAPER ON FLOOR – BACK OF SEAT	1
ST-8	III		2
ST-9	III		3
ST-10	IV	1-1/2-POUND NEWSPAPER ON SEAT – TENT EFFECT	1
ST-11	IV		2
ST-12	IV		3
ST-13	V	1-1/2-POUND NEWSPAPER ON FLOOR – FRONT OF SEAT – TENT EFFECT	1
ST-14	V		2
ST-15	V		3
ST-23	VI	3.0-POUND NEWSPAPER ON SEAT – TENT EFFECT	1
ST-24	VI		2
ST-25	VI		3
ST-26	VII	7000 WATT – HEAT PANEL – 18 INCHES ABOVE SEAT BOTTOM	1A
		– 12 INCHES ABOVE SEAT BOTTOM	1B
		– 6 INCHES ABOVE SEAT BOTTOM	1C
ST-27	VIII	7000 WATT – HEAT PANEL – 6 INCHES ABOVE SEAT BOTTOM AT 45 DEGREES	2A
		– 12 INCHES ABOVE SEAT BOTTOM AT 45 DEGREES	2B
		– 18 INCHES ABOVE SEAT BOTTOM AT 45 DEGREES	2C
ST-28	IX	7000 WATT – HEAT PANEL – 6 INCHES AWAY FROM SEAT BACK	3C
		– 12 INCHES AWAY FROM SEAT BACK	3B
		– 18 INCHES AWAY FROM SEAT BACK	3C
*ST-2A	I	1-1/2-POUND NEWSPAPER ON SEAT	4
*SPECIAL TESTS			

8-GEN-23429

NASA SEAT TEST
TEST CONDITIONS
TABLE IX

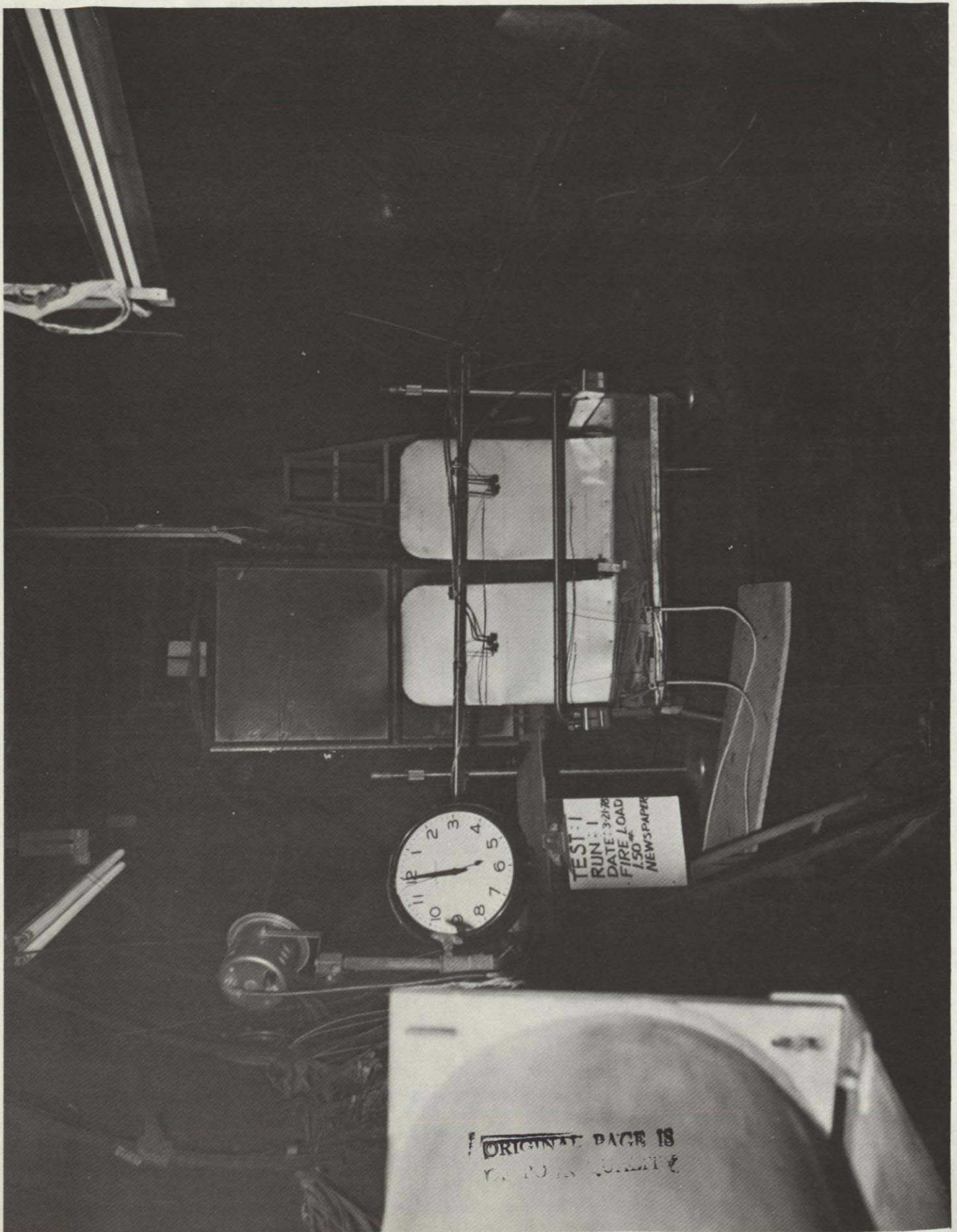


FIGURE 28. SEAT READY FOR TEST

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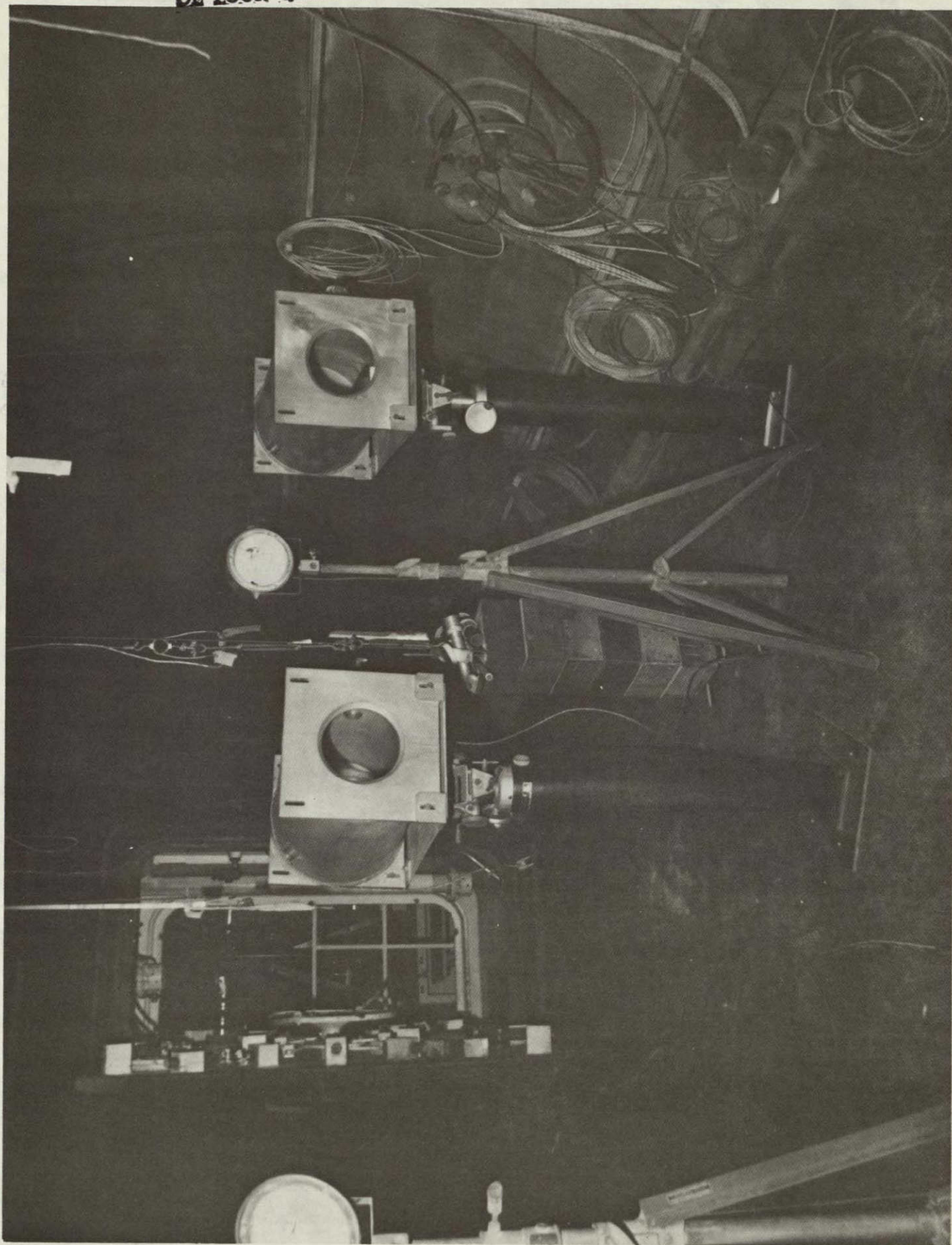
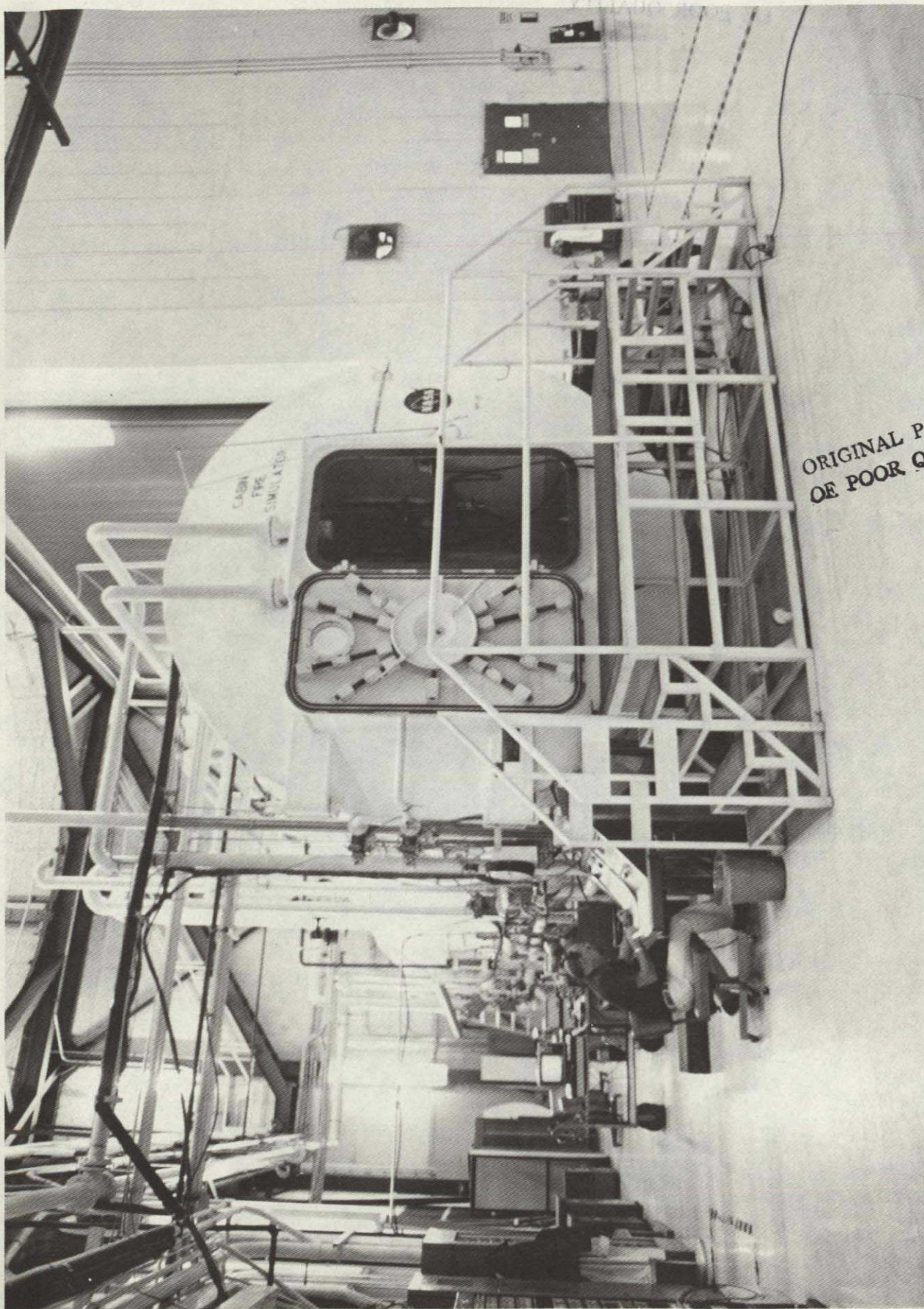


FIGURE 29. CAMERA AND TV SET-UP



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FIGURE 30. VIDEO RECORDER AND MONITOR

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FIGURE 31. RADIANT HEAT PANEL

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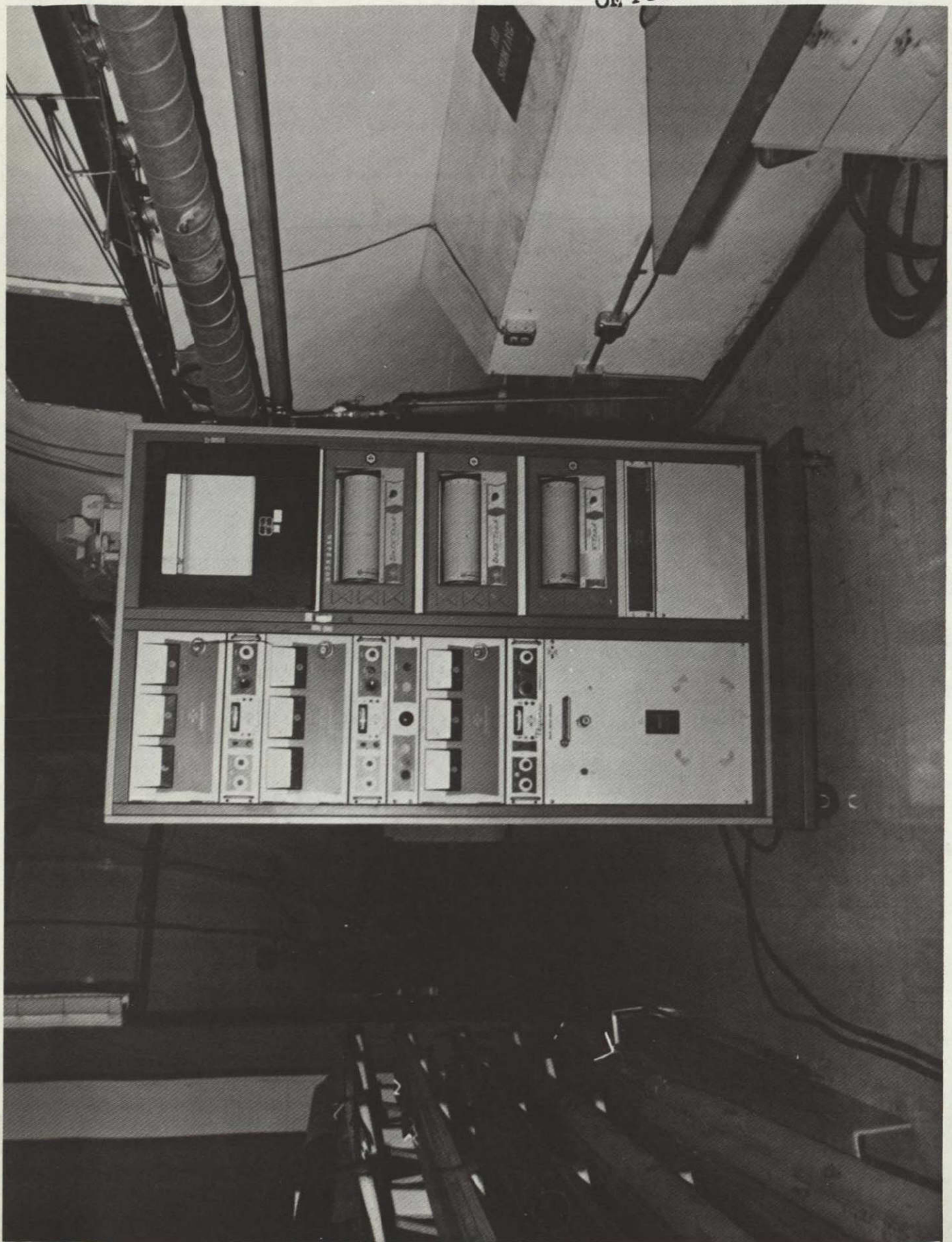


FIGURE 32. CONTROLLER FOR HEAT PANEL

5.2.7.1 Test No. 1 Category I

In this test, 1.5 pounds of newspaper was placed on the left hand seat bottom. The newspaper was folded over as if someone had placed it on the seat after reading. (See Appendix II, Figure 1). The ignitor was placed in between the bottom section of newspaper and the rest of the newspaper placed on top. Smoke appeared at approximately 16 seconds and first flames appeared at approximately 20 seconds. The resulting fire burned for 5 minutes then smouldered for the next ten minutes. The fire was allowed to smoulder overnight. Less than 0.1 pound of newspaper remained. (See Appendix II, Figure 2)

5.2.7.2 Test No. 2 Category II

In this test, 1.5 pounds on newspaper was again placed on the left hand seat bottom. The newspaper was laid on the seat pan in an unfolded condition (See Appendix II, Figure 3.)) and the ignitor placed on top of the paper. Power was turned on and smoke appeared at approximately 16 seconds, and flames at approximately 2 minutes then the fire appeared to go out. The test was terminated at 15 minutes. Weight of paper remaining after test was 1.46 pounds. (See Appendix II, Figure 4.

5.2.7.3 Test No. 3 Category I

In this test, 1.5 pounds of newspaper was positioned on the seat as shown in Appendix II, Figure 5. The ignitor was positioned in between and under the newspaper. Power was turned on and smoke appeared at approximately 16 seconds with flame following at approximately 21 seconds. Paper burned with small flame until approximately 2 minutes; then all paper became involved. Flames the height of the seat back were observed until approximately 9 minutes at which time fire diminished with flames around the edges of the remaining paper. The paper continued to smoulder until the test was terminated at 15 minutes. Only ashes remained after the test. All newspaper was completely consumed. (See Appendix II, Figure 6.

5.2.7.4 Test No. 2A Category I

This test was a duplication of Test No. 2, with the test condition shown in Appendix II, Figure 7. Smoke appeared at approximately 15 seconds and flame at approximately 18 seconds. Flames continued until 10 minutes and the paper continued to smoulder until test termination. Residue after the test weight 0.86 pounds. (See Appendix II, Figure 8)

5.2.7.5 Test No. 4 Category II

In this test, the newspaper was positioned under the front edge of the left hand seat pan. (See Appendix II, Figure 9). After ignition, smoke appeared at approximately 17 seconds with flames appearing at approximately 22 seconds. The fire burned around the edges of the edges of the paper for 2 minutes, then increased in intensity until 4 minutes. The fire then diminished but continued to burn until the test was terminated, and the smouldering residue was extinguished with a wet rag. Residue weighed 0.14 pounds. (See Appendix II, Figure 10).

5.2.7.6 Test No. 5 Category II

This test was similar to Test No. 4 with the following exceptions:

Smoke at approximately 17 seconds

Flame at approximately 24 seconds

Residue after test: 0.09 pounds

The before and after photos of this test are shown in Appendix II, Figure 11 and Appendix II, Figure 12.

5.2.7.7 Test No. 6 Category II

This test was similar to Tests No. 4 and 5 in that the fire started around the edges of the paper and continued burning around the edges until approximately 2 minutes. At this time all the newspaper became involved and the resulting fire continued until the test was terminated at 15 minutes. The residue remaining after this test was 0.01 pounds. Photos of this test are shown in Appendix II, Figure 13 and Appendix II, Figure 14.

5.2.7.8 Test No. 7 Category III

For this test, as well as Tests No. 8 and 9, the 1.5 pounds of newspaper was positioned behind the seat on the floor (See Appendix II, Figure 15). The igniter was positioned under the stack of newspaper and in between the bottom section. After ignition, smoke appeared at approximately 15 seconds with flame appearing at approximately 19 seconds. The resulting fire started slowly around the edges of the paper and continued until approximately 2 minutes. At this time, large flames started and continued until 8 minutes. The fire dwindled down and continued to smoulder until the end of the test. The residue after the test was 0.51 pounds. (See Appendix II, Figure 16).

5.2.7.9 Test No. 8 Category III

This test was the same as Test No. 7 with the following exceptions:

Residue after test was 0.07 pounds and the fire continued to smoulder even with wet rag on top of residue. Photos of this test are shown in Appendix II, Figure 17, and Appendix II, Figure 18.

5.2.7.10 Test No. 9 Category III

In this test, the newspaper was again placed under the rear edge of the left hand seat (See Appendix II, Figure 19). After ignition smoke appeared at approximately seconds, however, first flame did not appear until approximately 26 seconds. The resulting fire burned slowly until approximately 2 minutes. At this time, all of the paper became involved and large flames (as high as seat bottom surface and up seat back) were observed. The fire started to diminish in intensity at approximately 12 minutes. Small flames were observed to continue until the test was terminated at 15 minutes. The smouldering coals were extinguished by using a wet rag after the test was terminated. Residue at the termination of the test weight 0.03 pounds. (See Appendix II, Figure 20).

5.2.7.11 Test No. 10 Category IV

This test as well as Test No. 11 and 12 was conducted with 1.50 pounds of newspaper on the left hand seat bottom. In each of the three tests the newspaper was positioned on the seat such that it formed a tent over the ignitor. The ignitor was wrapped with tissue paper and one double page of newspaper folded over and under the ignition wire. (See Appendix II, Figure 21) After ignition, smoke appeared at approximately 16 seconds with first flames following at approximately 18 seconds. Medium height flames were observed at 2 minutes and continued until approximately 8 minutes at which time all but a very small amount of paper appeared to have completely burned. This small amount continued to burn and smoulder until approximately 14 minutes at which time all paper appeared to be consumed. After test termination, at 15 minutes, the seat was examined and it was found that all newspaper was in fact consumed. (See Appendix II, Figure 22).

5.2.7.12 Test No. 11 Category IV

This test appeared to be identical to Test No. 10 with the exception of the time the first smoke and flame were observed.

Smoke at 14 seconds vs. 16 seconds

Flame at 19 seconds vs. 18 seconds

Photos of this test are presented in Appendix II, Figure 23 and Figure 24.

5.2.7.13 Test No. 12 Category IV

This test also appeared to be identical to Test No. 10 with the following exceptions:

Smoke at 15 seconds vs. 16 seconds

Flame at 19 seconds vs. 18 seconds

Photos of this test are shown in Appendix II, Figure 25 and Appendix II, Figure 26.

5.2.7.14 Test No. 13 Category V

In this series of tests, Test Nos. 13, 14 and 15, 1.50 pounds of newspaper was placed on the floor in front of the left hand seat pan. The newspaper was placed in the tent configuration as shown in Appendix II, Figure 27. In this test, after ignition the first smoke appeared at approximately 13 seconds with the first flame appearing at approximately 15 seconds. The resulting fire was slow in starting in that it was approximately 3 minutes before all paper was on fire. At this time, flames as high as the bottom of the seat was observed. The fire continued at this level until approximately 8 minutes. A low, smouldering fire continued until the test was terminated at 15 minutes. The residue remaining weight 0.04 pounds (See Appendix II, Figure 28).

5.2.7.15 Test No. 14 Category V

In this test, (See Appendix II, Figure 29) the fire started quicker than in Test No. 13, two minutes vs. three minutes, however the first smoke and first flame appeared to be at approximately the same time:

First smoke at 12 vs. 13 seconds

First flame at 19 vs. 15 seconds

The fire burned with large flames until approximately 6 minutes, then the fire died down and continued to smoulder until approximately 10 minutes. At this time, the fire appeared to burn itself out. The test was terminated at 15 minutes. Residue after the test weighed 0.05 pounds. (See Appendix II, Figure 30)

5.2.7.16 Test No. 15 Category V

This test appeared to be identical with Test No. 14, in that the fire appeared to start at the same time and then burn down at approximately 6 minutes. It then continued to smoulder until 11 minutes at which time it appeared to be burned out. Time of the first smoke was approximately 13 seconds and the first flame at 17 seconds. Photos of this test are shown in Appendix II, Figures 31 and 32. Residue after this test weight 0.06 pounds.

5.2.7.17 Test No. 23 Category VI

In this series of tests, Tests No. 23, 24 and 25, 3.0 pounds of newspaper was placed on the left hand seat in the tent configuration. Each fire was started with the electric ignitor under the pile of paper. Also in each fire a great deal of smoke was generated, indicating incomplete combustion of the paper. In Test No. 23, (See Appendix II, Figure 33) the first smoke appeared at approximately 14 seconds - the same as 1.50 pounds of newspaper and the first flames at approximately 19 seconds - again the same as the 1.50 pounds of newspaper. The fire started very slowly and did not really burn well until approximately 4 minutes. It continued to burn briskly until approximately 8 minutes. At this time, the fire burned down and continued to burn with a low flame until the test was terminated at 15 minutes. The remaining embers were smothered by a wet rag. The residue remaining after this test weighed 0.90 pounds. (See Appendix II, Figure 34).

5.2.7.18 Test No. 24 Category VI

This test was identical to Test No. 23 with the following exceptions:

Smoke at 15 seconds vs. 14 seconds

First flame at 21 seconds vs. 19 seconds

Residue after test: 1.3 pounds vs. 0.90 pounds

Photos of this test are shown in Appendix II, Figure 35 and Appendix II, Figure 36.

5.2.7.19 Test No. 25 Category VI

In this test (See Appendix II, Fig. 37) the fire started very similar to Test No. 23 and 24 with smoke appearing at approximately 14 seconds and the first flames at approximately 18 seconds. After the first flame all the paper became involved very quickly with large flames which continued until approximately 5 minutes. The fire then died down and small flames continued until approximately 7 minutes. At 7 minutes, the only fire appeared to be caused by smouldering embers. This condition existed until the test was terminated at 15 minutes. At this time a wet rag was used to extinguish the glowing embers. The residue after this test was 1.52 pounds. (See Appendix II, Figure 38).

5.2.7.20 Tests No. 26, 27 and 28 Category VII, VIII and IX

In these nine tests, the radiant heat panel was used as the source of heat. This was directed upon the right hand seat of the double seat combination. The newspaper was not used nor were the two calorimeters mounted over the seat. The heat panel was turned on - left on for 15 minutes and then turned off. Thermocouple readings were obtained during each test. Photos of each test are shown in Appendix II, Figure 39 through Figure 56.

5.3 Test Results

The data from each of the tests is presented in Appendix III. Each set of data consists of 6 plots: Plot 1-1 contains data from the two calorimeters and the two thermocouples (TC-19 and TC-20) next to each calorimeter. It will be noted that the calorimeter readings of the calorimeter (C2) and the thermocouple (TC-20) not over the fire are very low, therefore, they will be discounted during the analysis. Plot 2-1 of the set contains data from the right hand seat (the non-fire seat) with TC-5, TC-6 and TC-7 being on the seat bottom and TC-12 and TC-13 being on the seat back. Plot 3-1 of each set is the data from the left hand seat (the fire seat) with TC-1, TC-2 and TC-3 on the seat bottom and TC-8 and TC-9 on the seat back. Plot 4-1 records the data of the thermocouples between the two seats; TC-4 on the seat pan and TC-10 and TC-11 in the space between the seat backs. Plot 5-1 presents data from the thermocouples on the front edge of the seat pan (TC-14, TC-15 and TC-16); and on the lower surface of the seat back (TC-17 and TC-18). The location of the thermocouples and calorimeters with relation to the seat is shown in Figure 26. Plot 6-1 shows the Cabin Delta Pressure in inches of water. Due to a programming error, all the pressure plots read minus pressure, which was not the case. When reading the data from Plot 6-1 for each set, the minus readings should be read as positive.

5.3.1 Category I - Tests No. 1, 2, 2A and 3

It became apparent very quickly that little or no consistency existed between the four tests (1.5 pounds of newspaper on the seat) in this category. The calorimeter data ranged from approximately 0.6 watts/cm² in Test No. 2 to over 2.9 watts/cm² in Test No. 2A. The shape of the calorimeter curves was similar in Test No. 1 and 2 but was radically different for Tests No. 2, 2A and 3. The thermocouple readings over the fire (TC-19) varied from a low of approximately 60°C in Test No. 2 to approximately 200°C in Test No. 3. This shows the large range of not only the amount of heat but also the difference in heat per unit area, which was present 18 inches above the fires.

The differences between the fires was even more apparent when the thermocouple readings on the left hand seat were compared. In Test No. 2, all 5 readings remained essentially constant (approximately 30°C) while in Test No. 3 the highest temperature reached approximately 450°C (TC-09) and the lowest temperature was approximately 60°C (TC-02). Further the shape of the curves in each test was considerably different. These curves are presented in Plot 3-1 of Test No. 1, 2, 2A and 3 in Appendix III.

It is believed that the wide variation in curve shape and temperature readings was caused by the way the newspaper was placed on the seat prior to the start of each fire test. An example of this is shown in the data from Test No. 2 where the newspaper was placed on the seat without unfolding it. Also, it is believed that placing the ignitor on top of the paper instead of under it contributed greatly to the minimal heat in Test No. 2.

5.3.2 Category II - Tests No. 4, 5 and 6

In this series of tests, (1.5 pounds of newspaper on the floor in front of the seat), the placement of the newspaper was more closely controlled than in the previous series. Each section of newspaper was opened, as if it had been read, then refolded. It will be noted that the calorimeter readings (Plot 1-1) and the thermocouple readings over the fire showed the same trend, however the readings were much lower. This was to be expected as the fire was on the floor instead of the seat pan. This series was conducted primarily to obtain a temperature profile of a fire on the floor in front of the seat.

The thermocouple data on the right hand seat (Plot 2-1) indicate higher readings than in the previous series and show a similar trend in the shape of the curves. It will be noted that a time shift for the heat intensity occurred, however the same general trend occurred in each of the three tests.

Plot 3-1 for each test show the same general trend as Plot 2-1 in that the curve shapes are generally similar. The amount of heat recorded was higher but this was expected as the fire was positioned under this seat. The same general trend follows in Plot 4-1 and Plot 5-1 for each test in this series. These data are presented in Appendix III.

It is believed that the higher readings were caused by the more complete burning of the paper in this series of tests. The resultant hotter and longer fires caused more heat on the sheet metal bottom of the seat pan. The higher seat temperatures were then transferred to other parts of the seat by conduction and radiation. If the seat had been outfitted with cushions, it is believed that this conduction and radiation effect would not have been as great, which would have lowered the temperature readings on those portions of the seat not directly in contact with the fire.

Even though a generalized correlation of the data was obtained by this series of tests it was believed that the results were still not consistent enough to be considered a "standard fire."

5.3.3 Category III - Tests No. 7, 8 and 9

In this series of tests, (1.5 pounds of newspaper on floor - back of seat) very little correlation between the tests occurred. The curves shape was similar for the thermocouples on the right hand seat however the readings were very dissimilar. (See Plot 2-1).

The shape and readings of the thermocouple data for the left hand seat were also very dissimilar as seen in Plot 3-1. Even the data for the two thermocouples on the back surface of the seat showed no correlation. No explanation can be given for the wide variance of the results from these three tests.

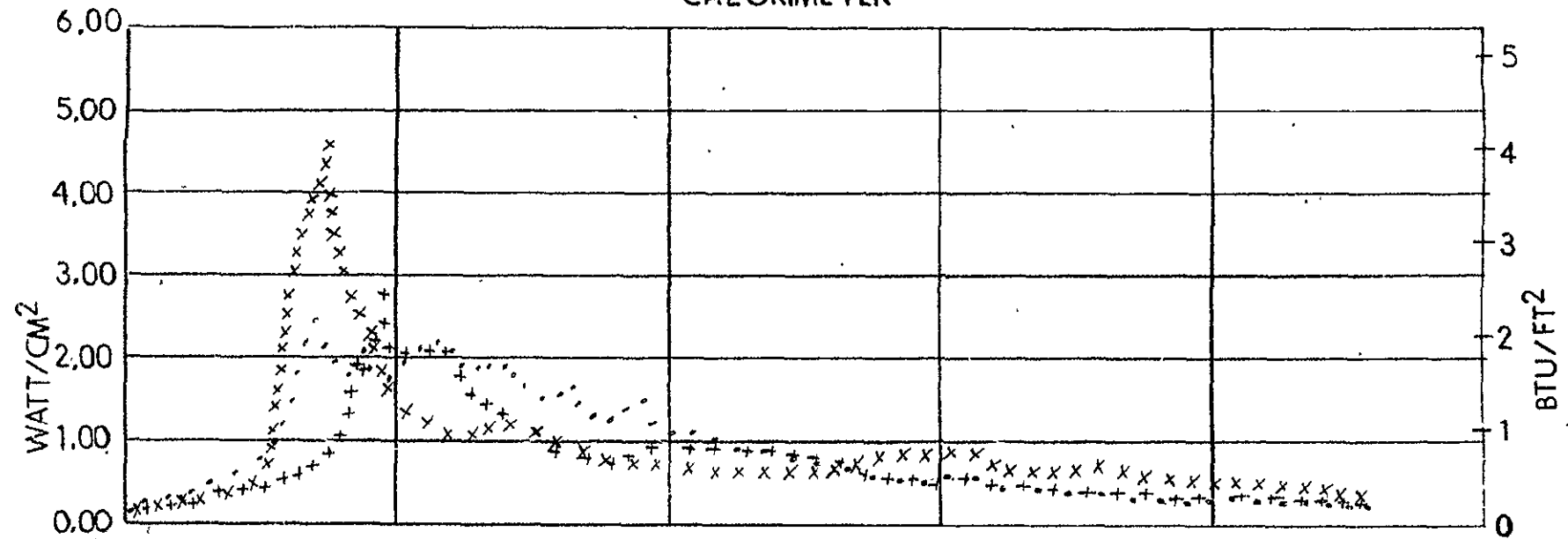
Data from this test series as well as the two previous series indicate that the degree of compaction and placement of the newspaper will determine to a large extent the severity of the resulting fire. In order to eliminate this lack of consistency the newspapers will be placed such that a tent condition will result in the next series of tests. Also each section of newspaper will be opened as if the paper had been read, then refolded.

5.3.4 Category IV - Tests No. 10, 11 and 12

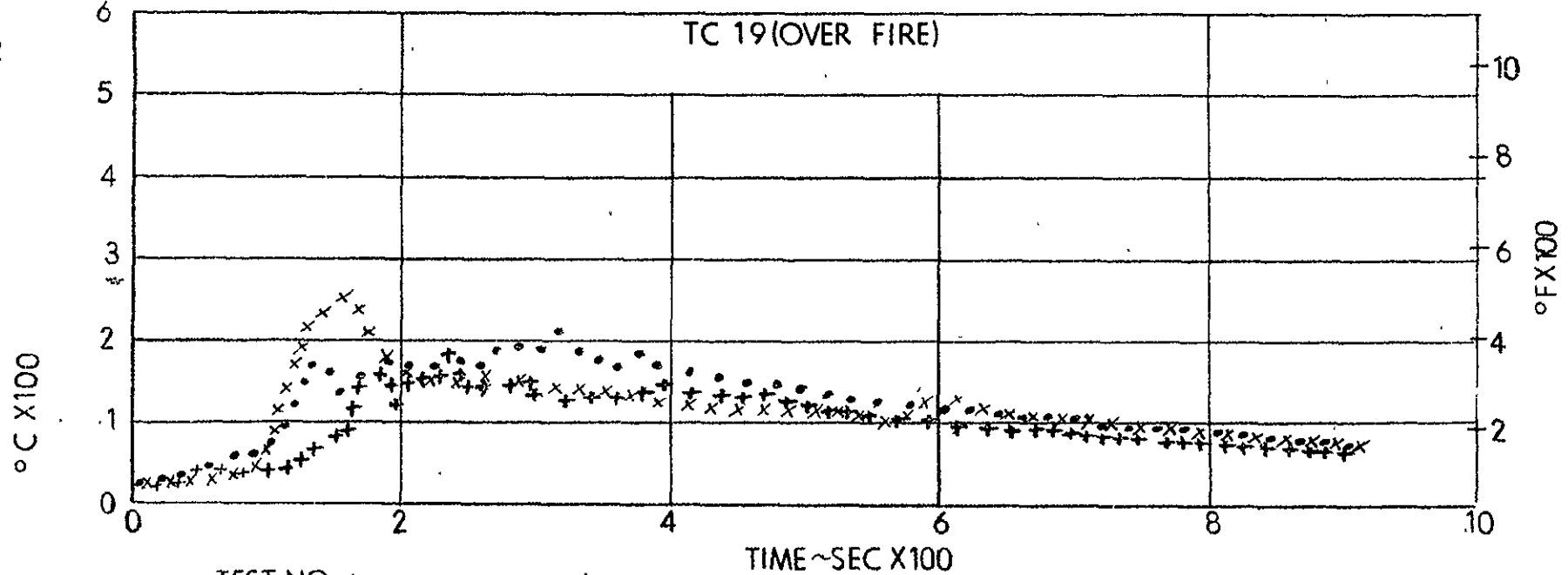
It appeared that good correlation was occurring between the tests in this series (1.5 pounds of newspaper - tent effect - on seat) when the tests were being conducted, as each test looked identical to the others on the television recordings of the fire. This was later confirmed when the computer printouts were plotted and the data from each test compared with the other tests in the series. These comparative data are shown in Figures 33 through 44. Figure 33 shows the data from the calorimeter and the thermocouple over the fire. Figures 34 through 38 are for the data from the left hand seat, the seat under the fire. Figures 39 through 41 are for selected data from the thermocouples on the right-hand seat (the non-fire seat). Figures 42, 43 and 44 present the data from the thermocouples between the seats.

As a result of the very close correlation between the three tests, it is believed that the 1.5 pounds of newspaper when placed in the tent condition will provide a repeatable, consistent fire and this condition should be considered as the "standard fire" source. The computer curves for each thermocouple are shown in Appendix III.

CALORIMETER



TC 19(OVER FIRE)

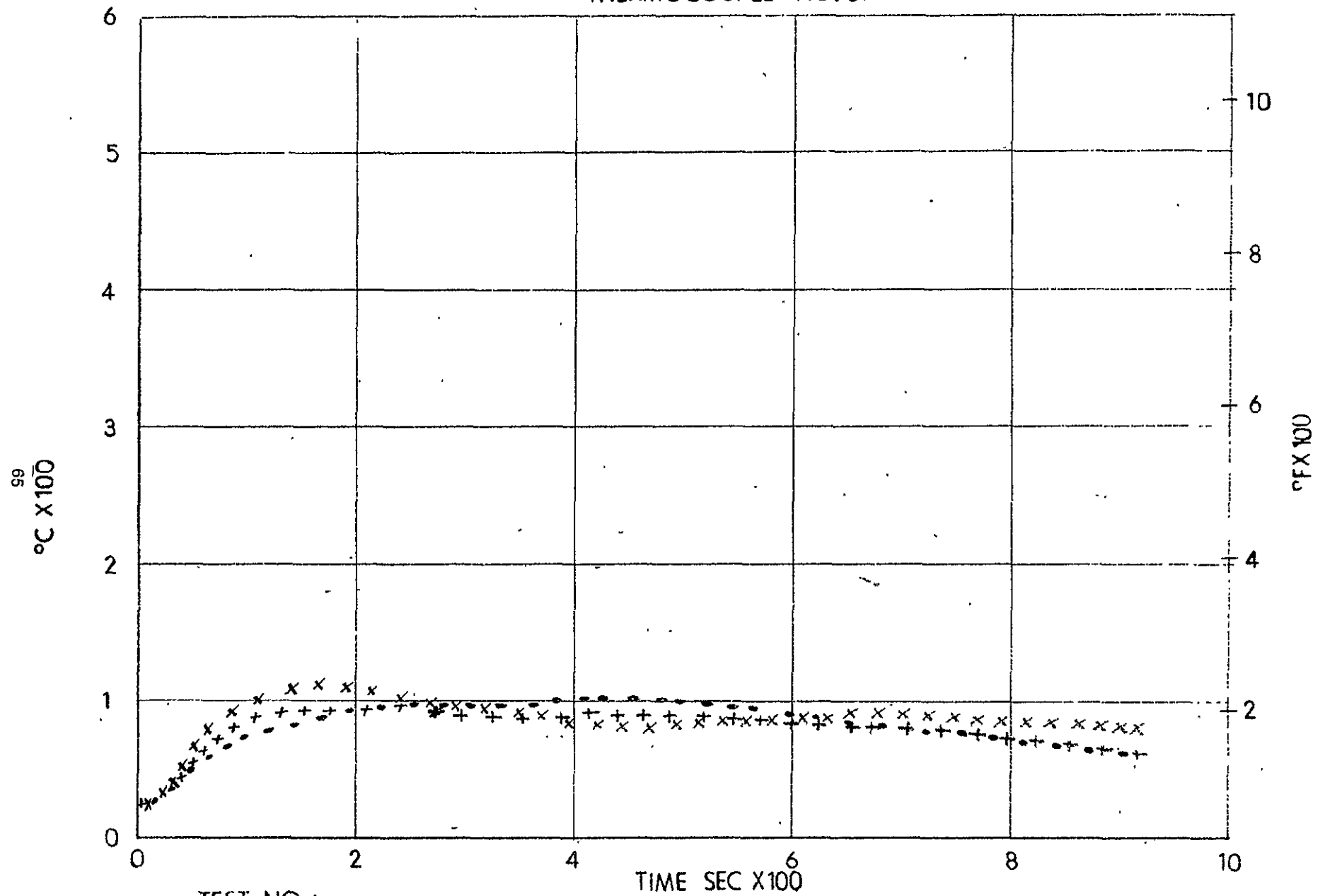


TEST NO. :

- 10 xxx
- 11 •••
- 12 +++

FIGURE NO. 33
COMPARATIVE CURVES°

THERMOCOUPLE NO. 01



TEST NO :

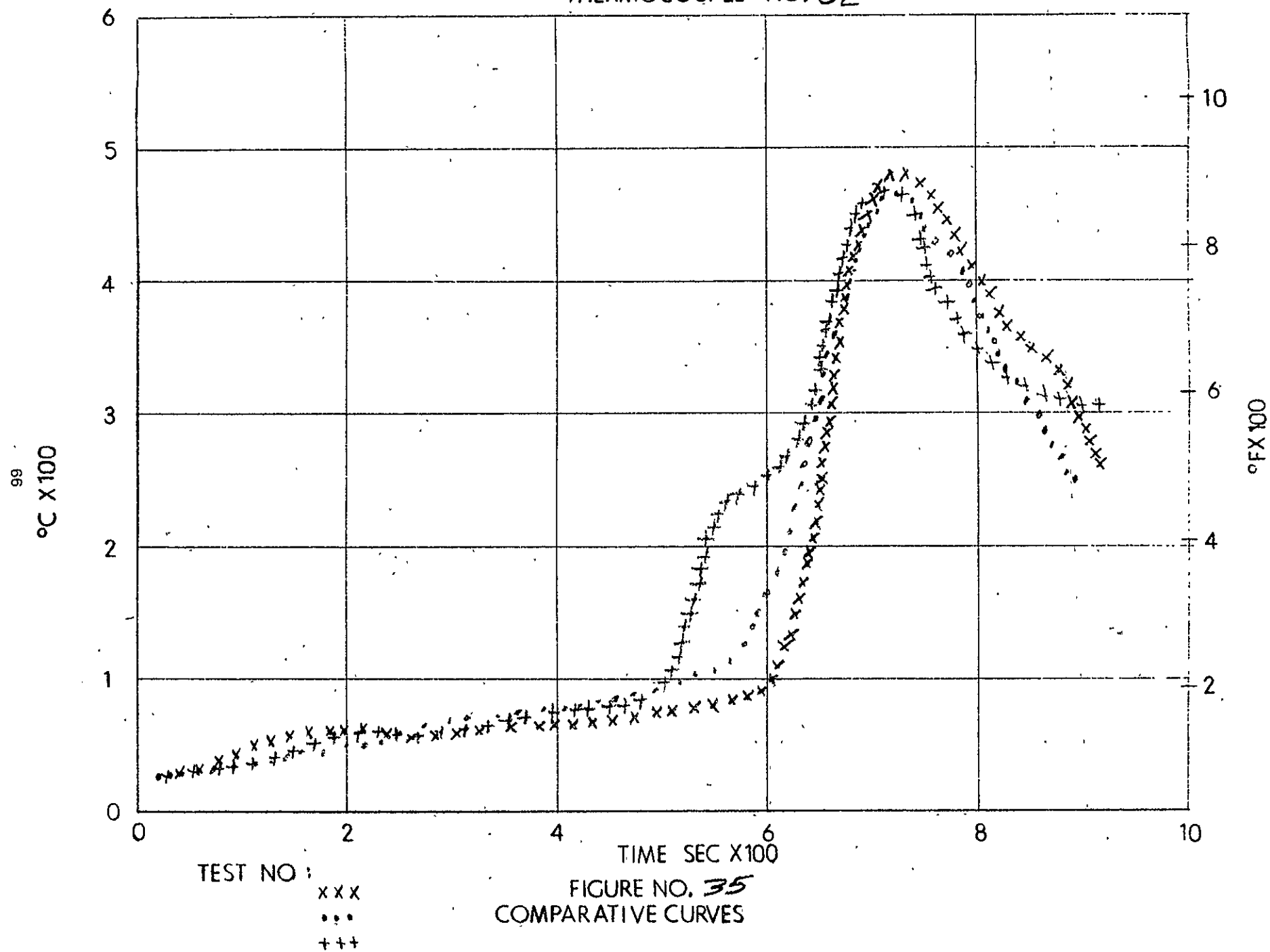
10 x x x

11 . . .

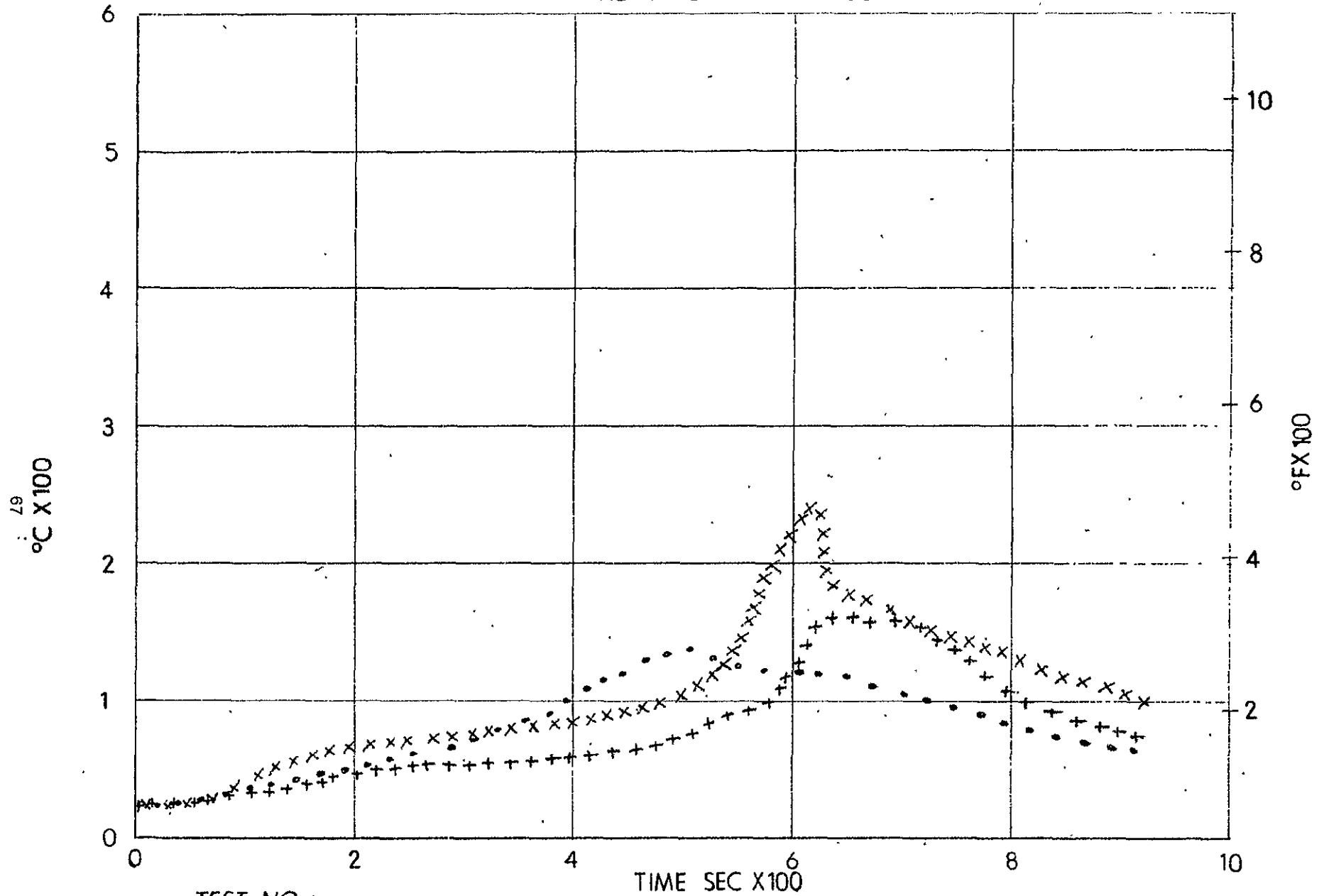
12 + + +

FIGURE NO. 34
COMPARATIVE CURVES

THERMOCOUPLE NO. 02



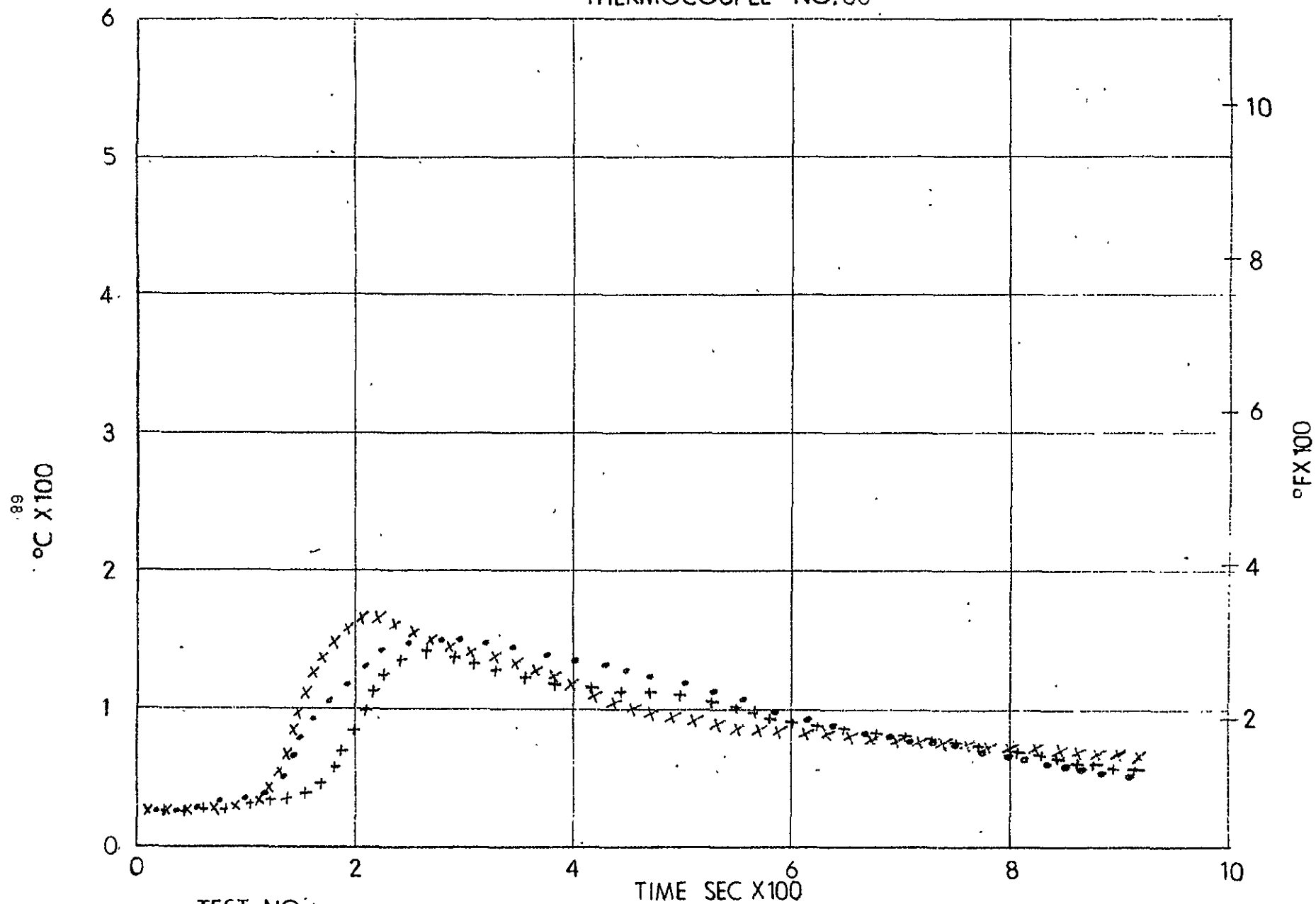
THERMOCOUPLE NO.03



TEST NO :
 10 x x x
 11 . . .
 12 + + +

FIGURE NO. 36
 COMPARATIVE CURVES

THERMOCOUPLE NO.08



TEST NO.:

10 x x x

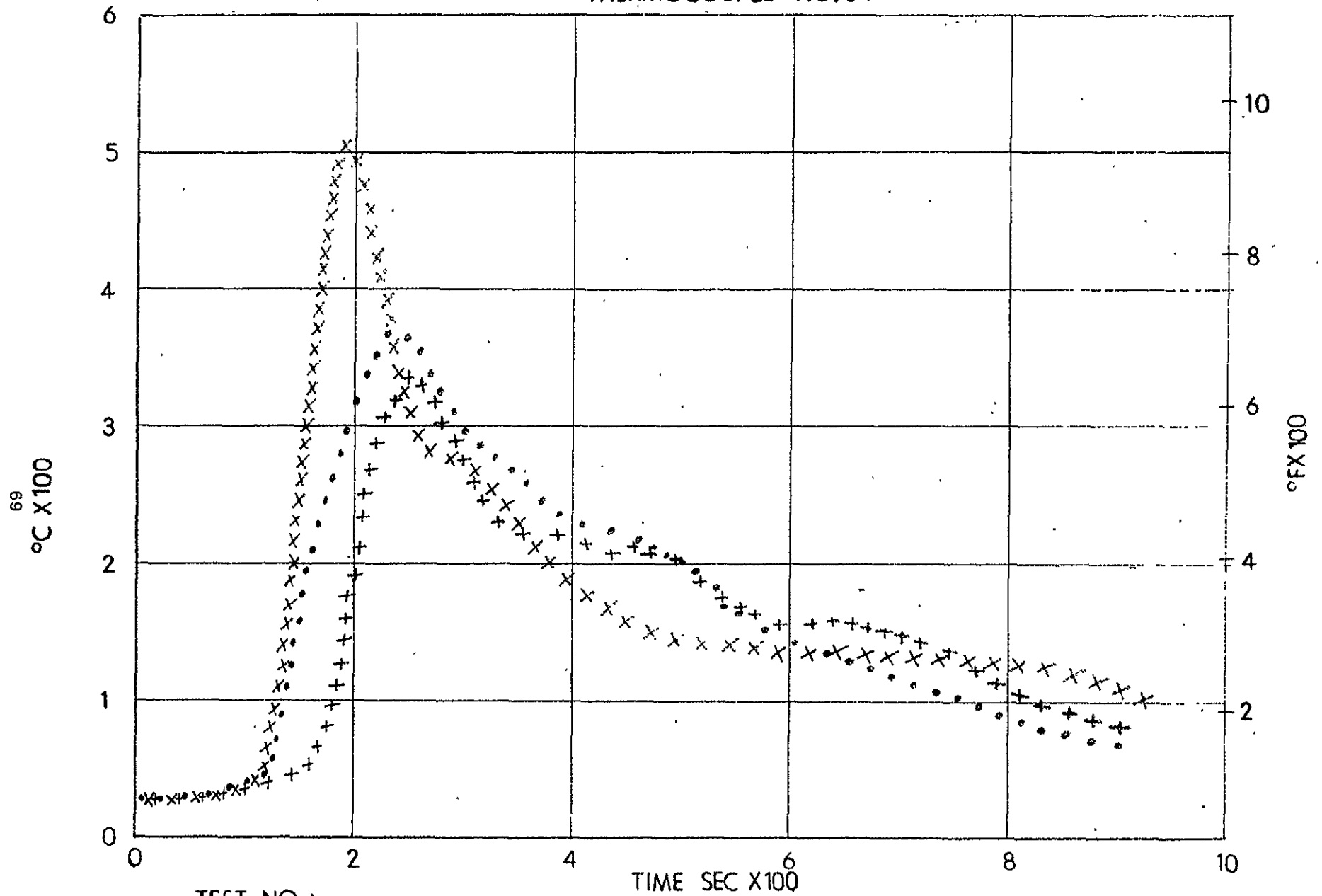
11 . . .

12 + + +

FIGURE NO. 37

COMPARATIVE CURVES

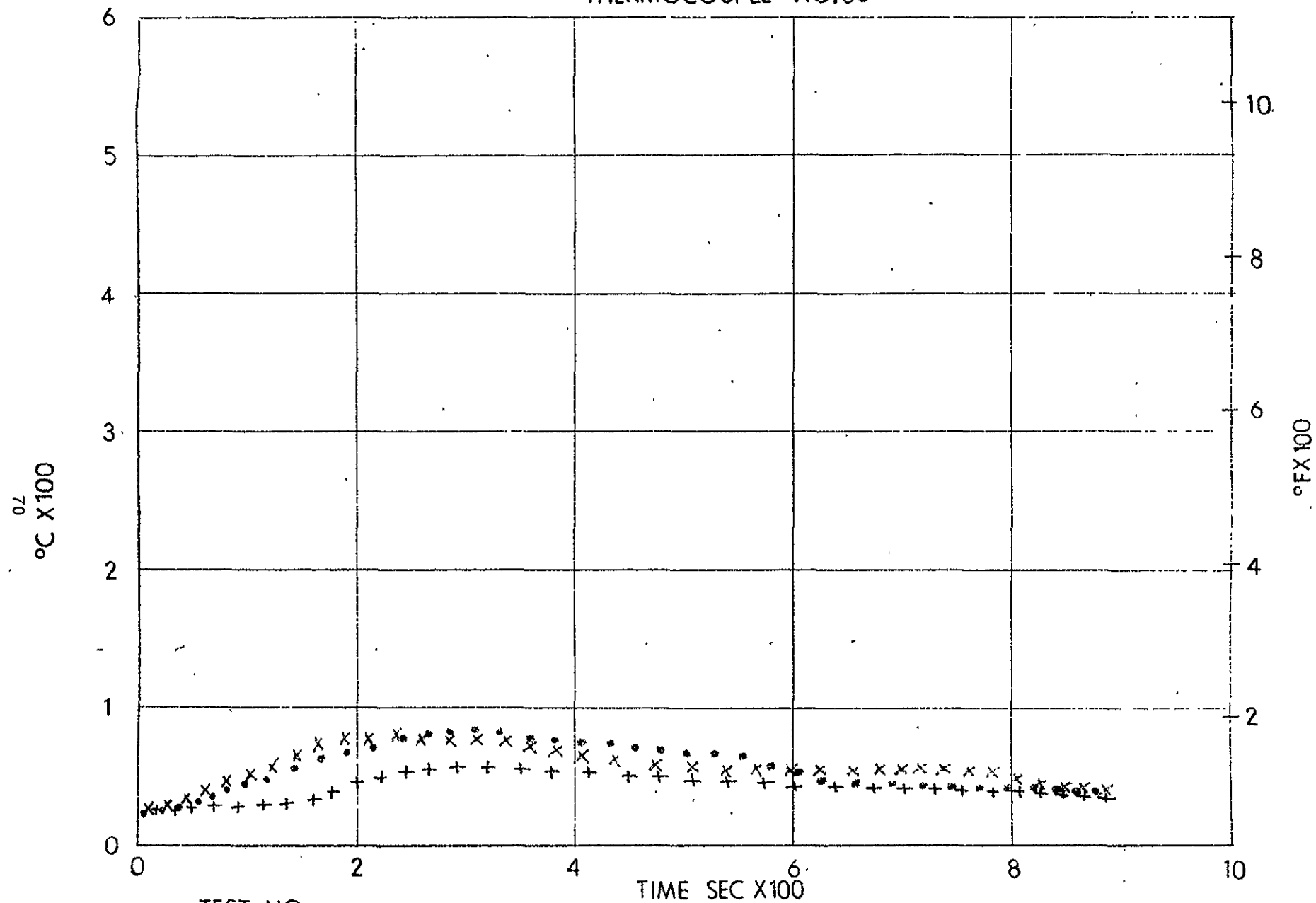
THERMOCOUPLE NO.09



TEST NO :
 10 x x x
 11 . . .
 12 + + +

FIGURE NO. 38
 COMPARATIVE CURVES

THERMOCOUPLE NO.05



TEST NO :

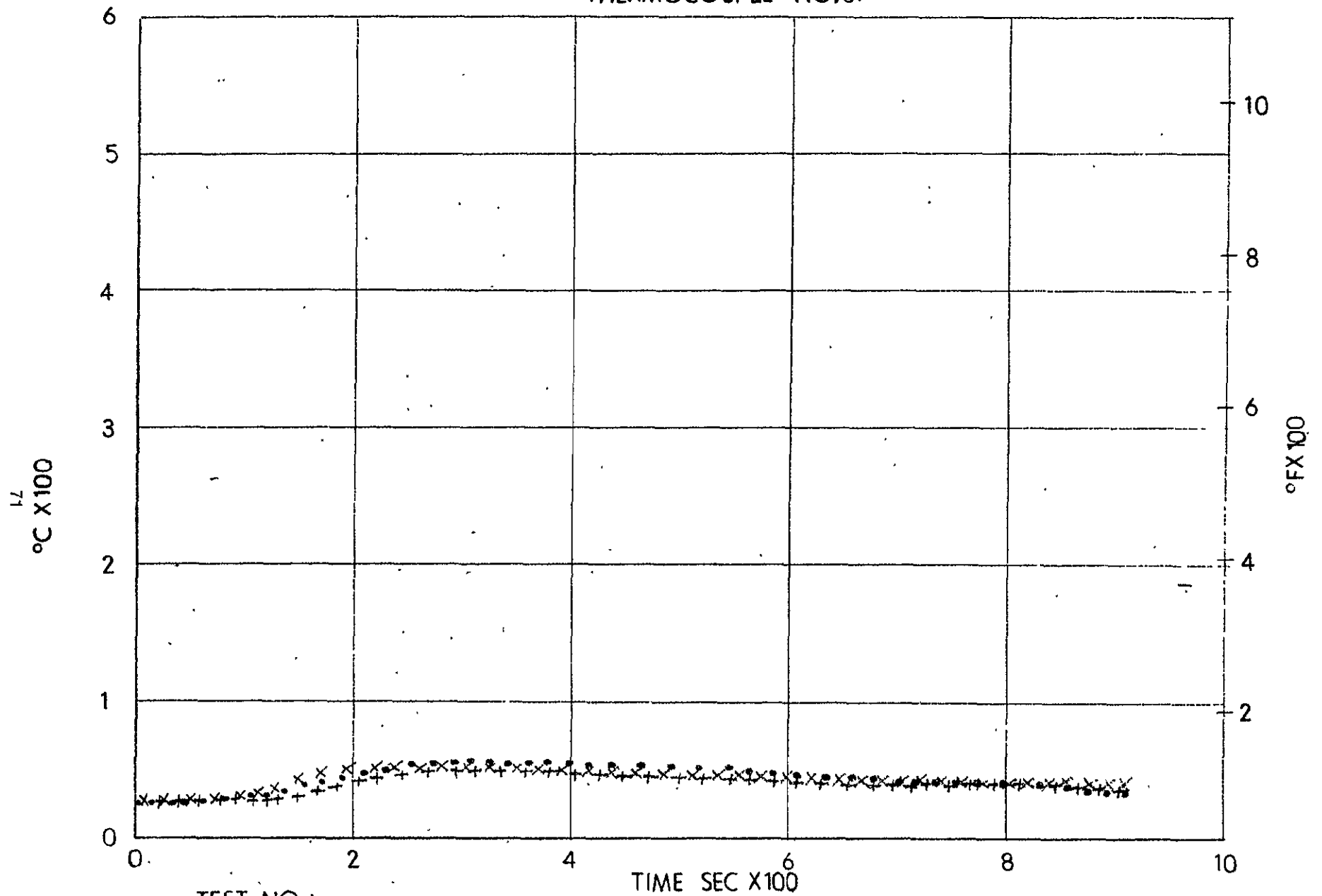
10 x x x

11 . . .

12 + + +

FIGURE NO. 39
COMPARATIVE CURVES

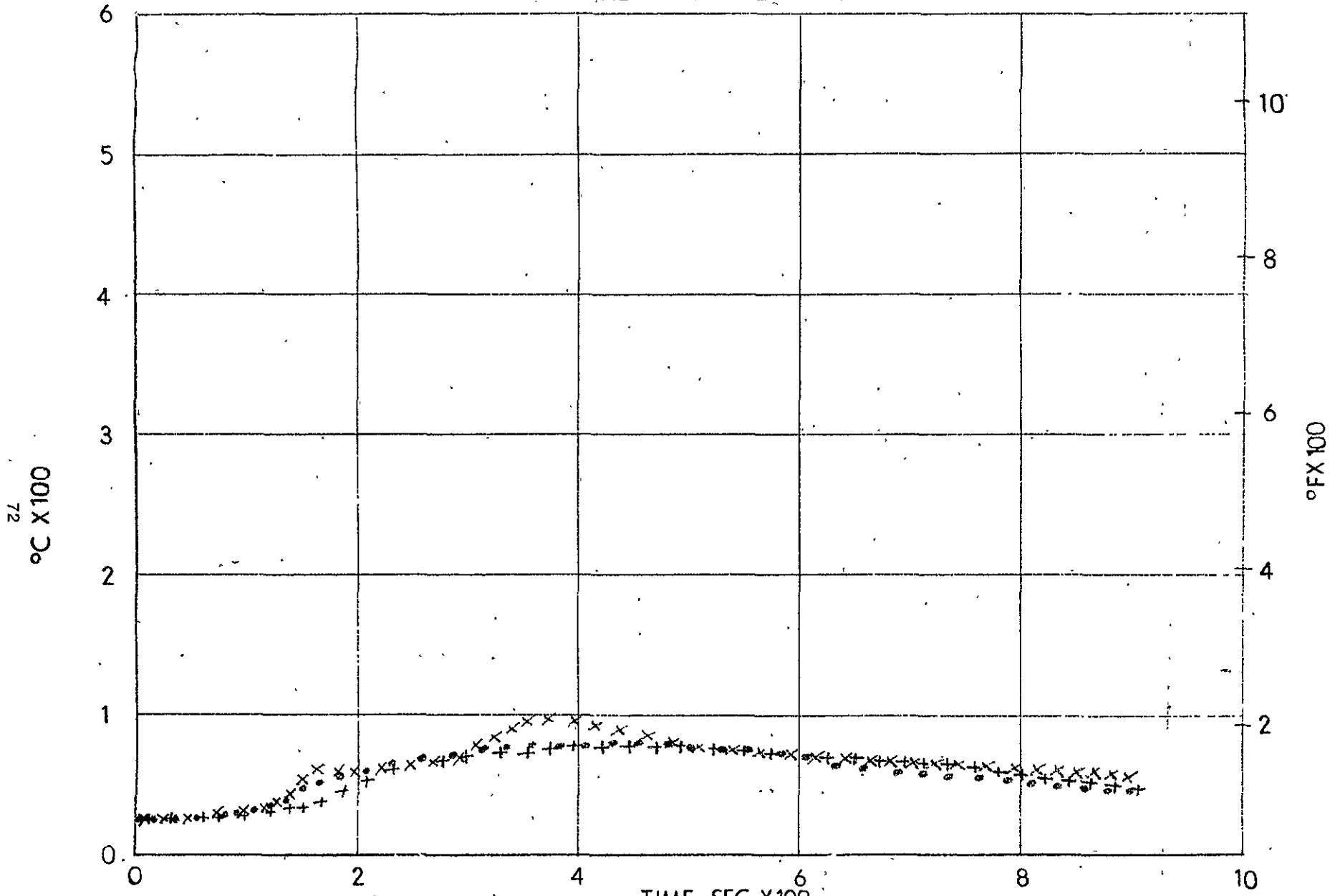
THERMOCOUPLE NO.07



TEST NO :
 10 x x x
 11 . . .
 12 + + +

FIGURE NO. 40
 COMPARATIVE CURVES

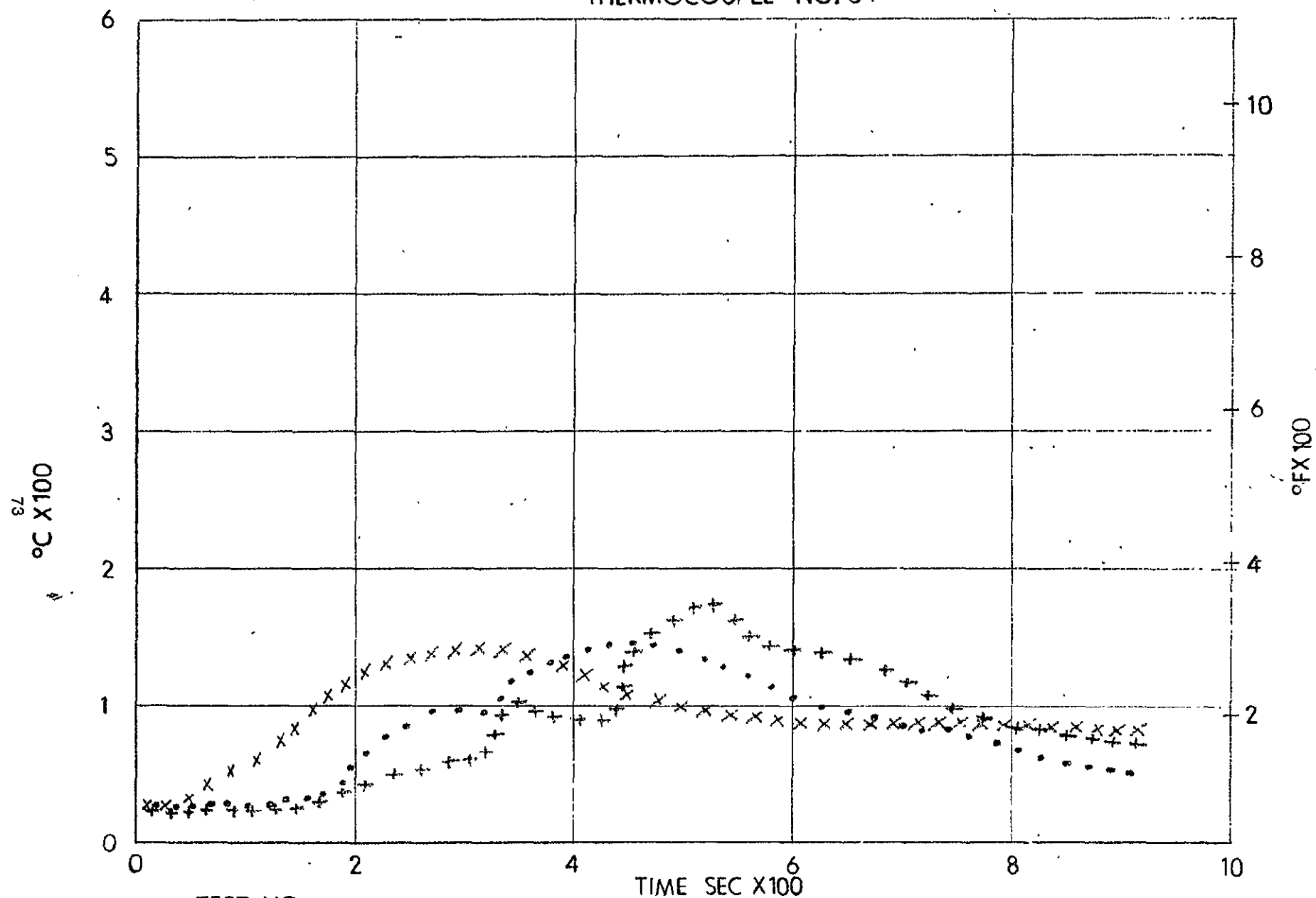
THERMOCOUPLE NO.12



TEST NO :
 10 ····
 11 ····
 12 ++++

FIGURE NO. 41
 COMPARATIVE CURVES

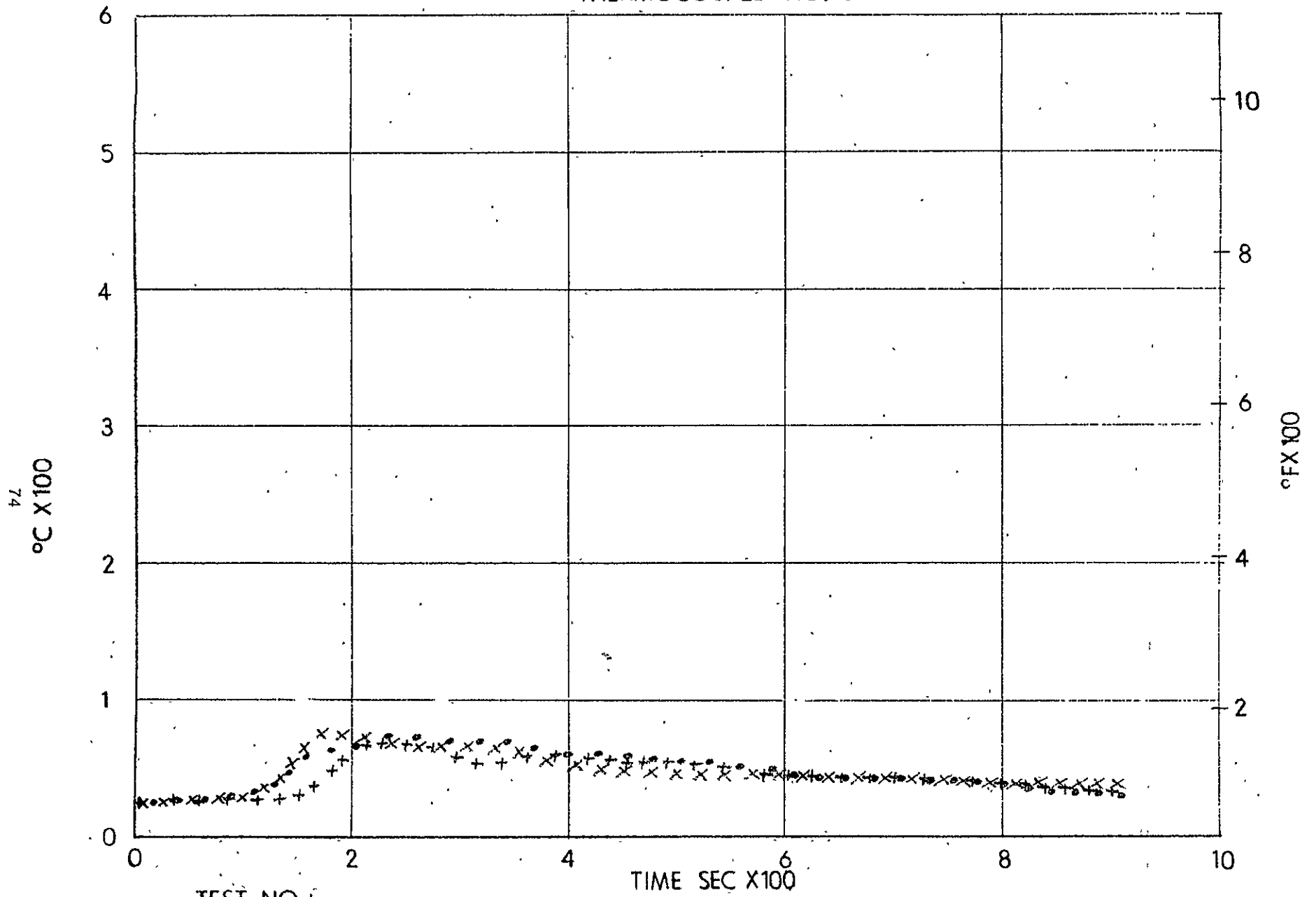
THERMOCOUPLE NO. 04



TEST NO :
 10 x x x
 11 . . .
 12 + + +

FIGURE NO. 42
 COMPARATIVE CURVES

THERMOCOUPLE NO.10



TEST NO :

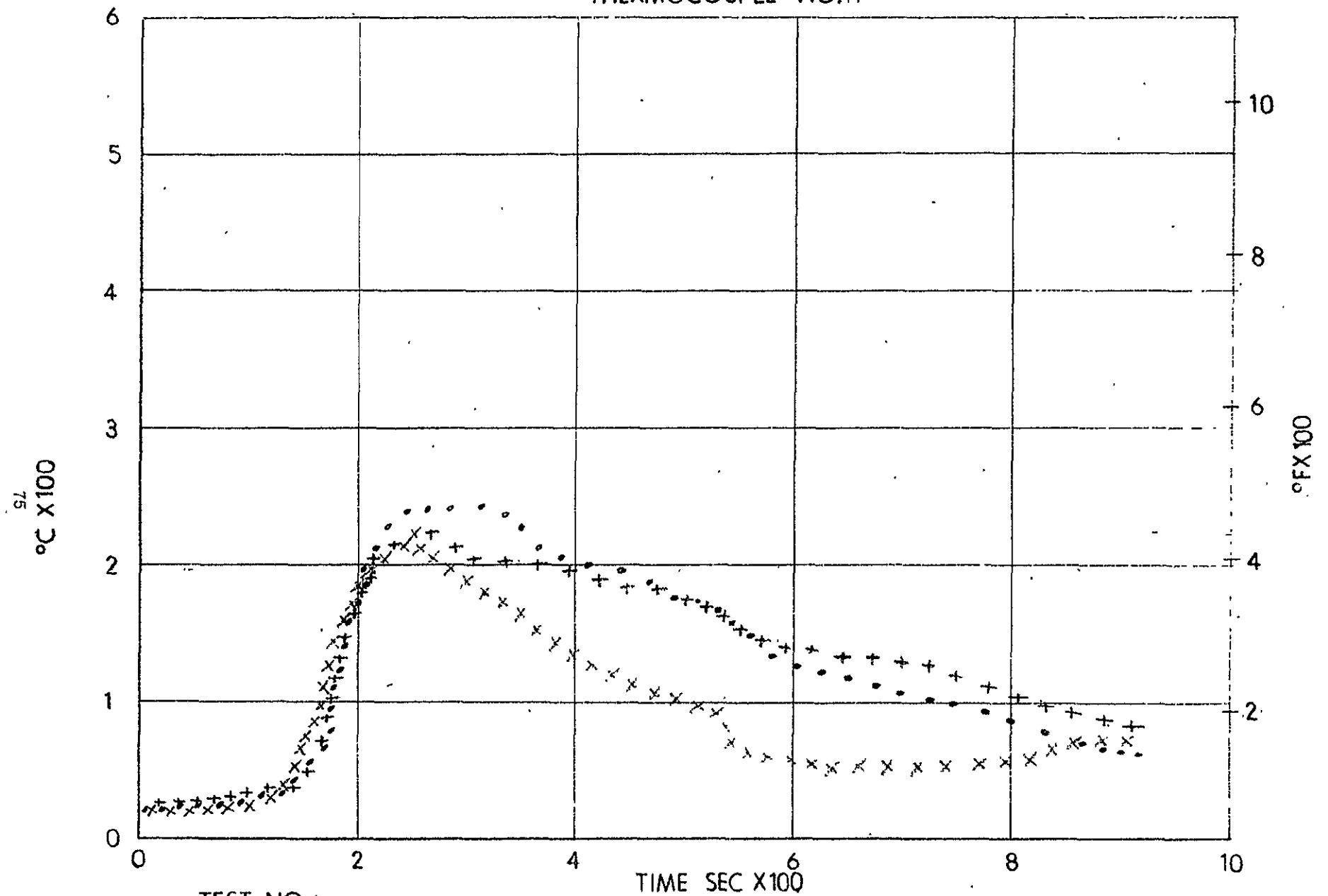
10 x x x

11 . . .

12 + + +

FIGURE NO. 43
COMPARATIVE CURVES

THERMOCOUPLE NO.11



TEST NO :
 10 x x x
 11 • • •
 12 + + +

FIGURE NO. 44
 COMPARATIVE CURVES

5.3.5 Category V - Tests No. 13, 14 and 15

This series of tests (1.5 pounds of newspaper - tent effect - on floor in front of seat) was conducted primarily to validate the results of the newspaper tent condition from the previous series and to obtain additional data from a floor fire. It will be noted that the data from all three tests was similar and a good correlation of data occurred. This correlation was not as good as the previous series, however it is believed that the data showed enough consistency to validate the tent configuration with the newspaper.

The comparative curves are presented in Figures 45 through 53. Figures 45, 46 and 47 show the data from the thermocouples on the front edge of the seat. Figures 48, 49 and 50 show the data from the thermocouples on the left hand seat bottom and Figures 51 and 52 show the data from the thermocouples on the left hand seat back. The calorimeter data and the data from the thermocouple over the seat are compared in Figure 53. The individual traces for the three tests in this series are contained in Appendix III.

5.3.6 Category VI - Tests No 23, 24 and 25

This series of tests (3.0 pounds of newspaper - tent effect - on seat) was conducted to determine what effect - if any - doubling the fuel would have on the resulting fire. Two of the three fires were similar in that the fires started slowly with complete ignition not taking place until approximately 4 minutes. In the third test, the ignition started very quickly with large flames for approximately 5 minutes then the fire died down and continued to burn with low flames until approximately 7 minutes. After 8 minutes all three tests had only very low flames and much smoldering until the tests were terminated at 15 minutes. In each test, large amounts of smoke was generated indicating incomplete combustion of the newspaper. This was confirmed by the residue remaining after each test was terminated.

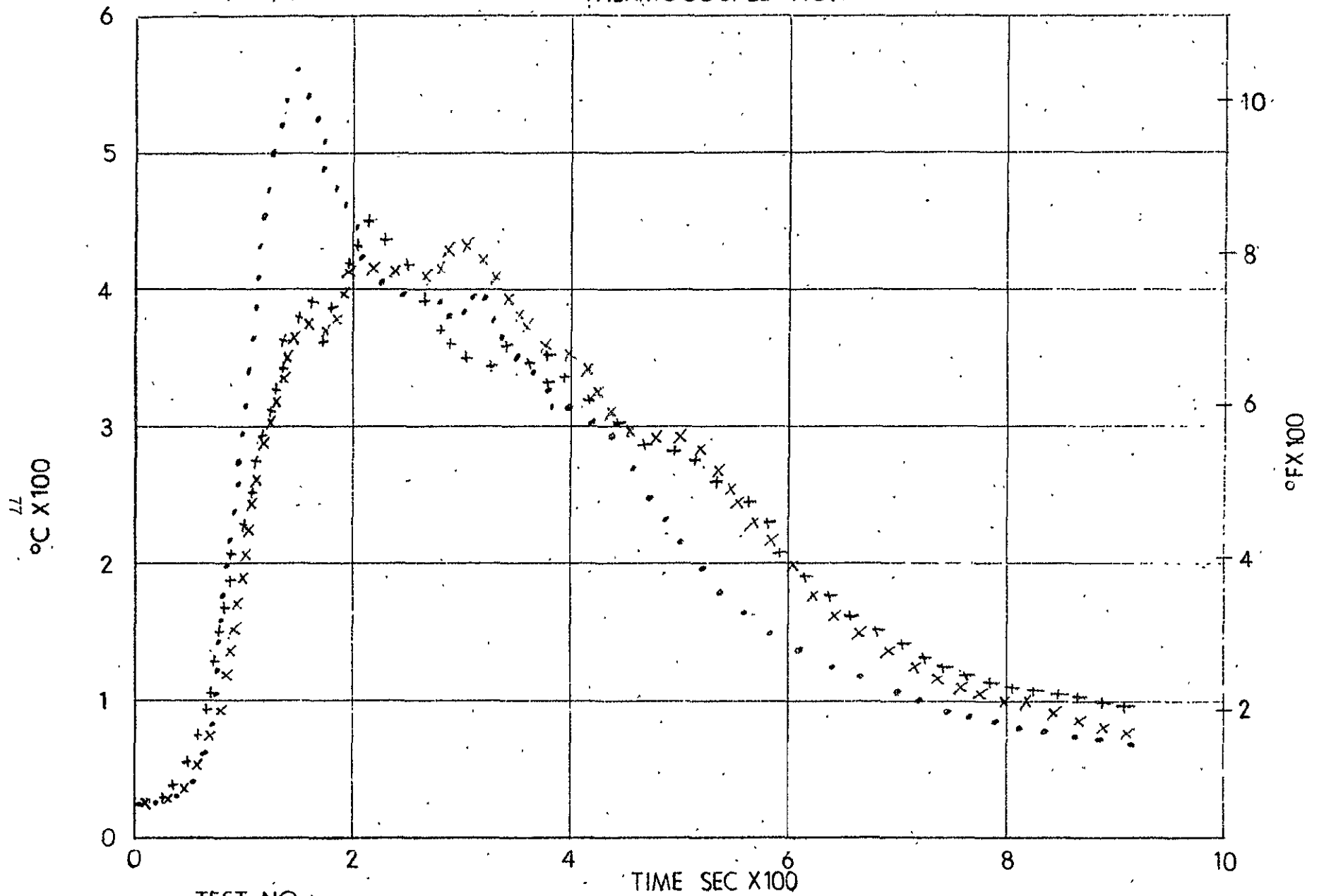
The computer printed curves (See Appendix III) show some degree of correlation between the three tests but not to the extent that the 1.50 pound of newspaper tests exhibited.

5.3.7 Category VII, VIII and IX - Tests No. 26, 27 and 28

The nine tests in these three series of tests utilized the radiant heat panel as the source of heat. The panel was positioned relative to the seat as shown in Table II. Only the thermocouple data was recorded as it was believed that the calorimeter readings would be meaningless due to the placement of the panel.

Prior to conducting this series of tests the panel was calibrated by generating the heat from the panel upon a grided sheet of asbestos. (See Figure). The calorimeter was placed over each grid intersection and readings were obtained at three distances away from the grid - 6 inch, 12 inch and 16 inch. The results of the calibration are shown in Table X.

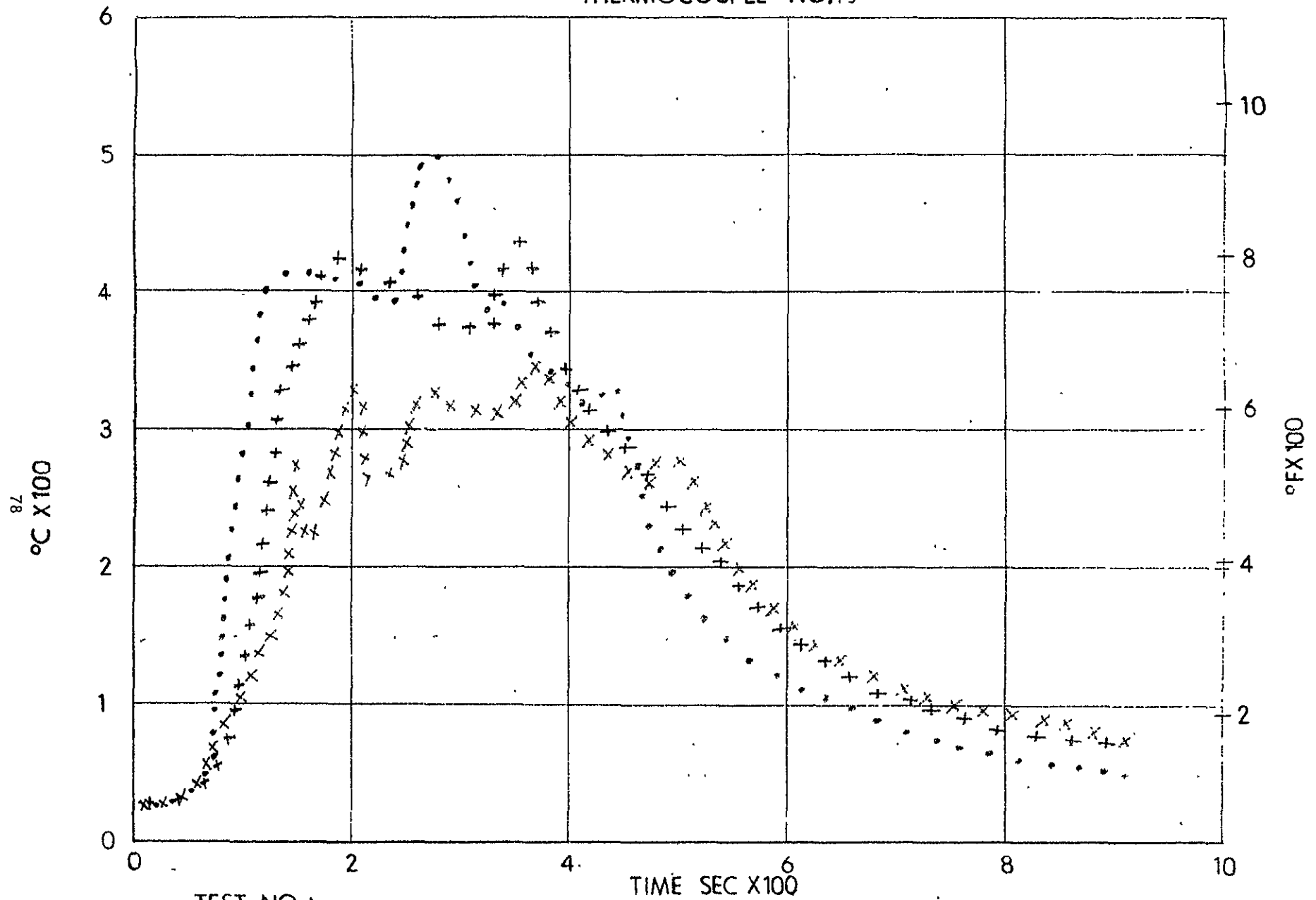
THERMOCOUPLE NO.14



TEST NO :
 13 x x x
 14 • • •
 15 + + +

FIGURE NO. 45
 COMPARATIVE CURVES

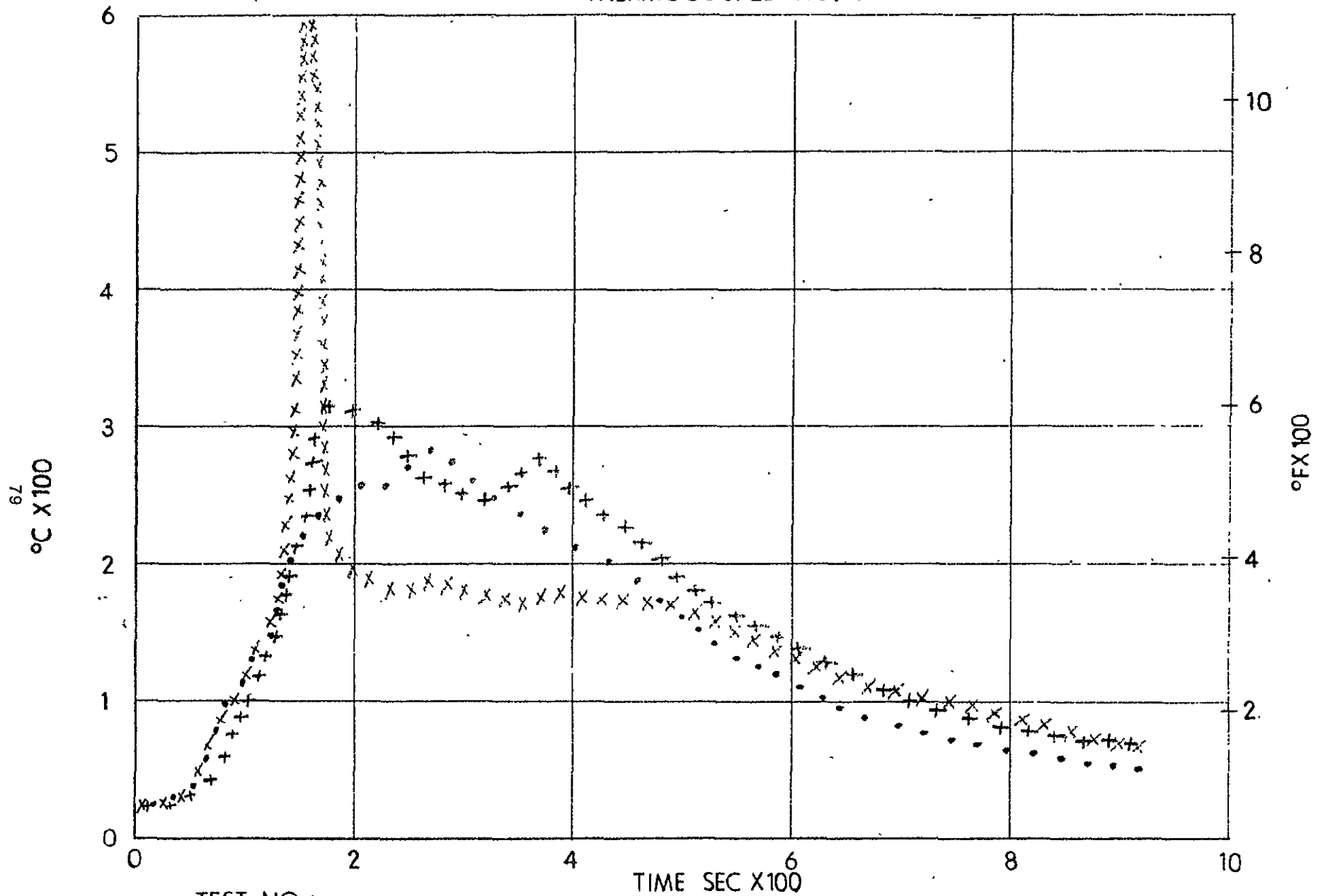
THERMOCOUPLE NO.15



TEST NO :
 13 xxx
 14 ooo
 15 ++

FIGURE NO. 46
 COMPARATIVE CURVES

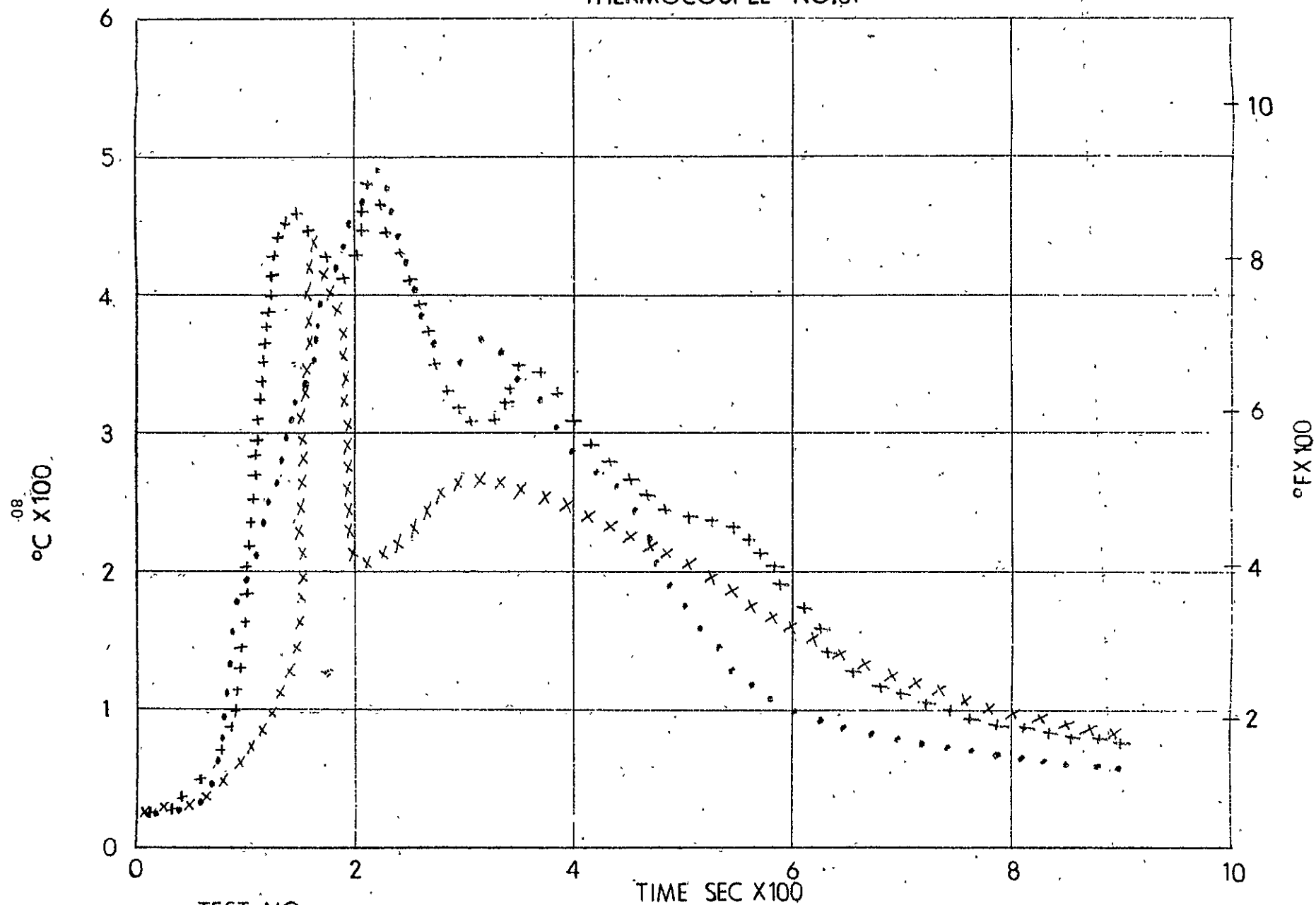
THERMOCOUPLE NO.16



TEST NO :
 13 x x x
 14 . . .
 15 + + +

FIGURE NO. 47
 COMPARATIVE CURVES

THERMOCOUPLE NO.01



TEST NO.:

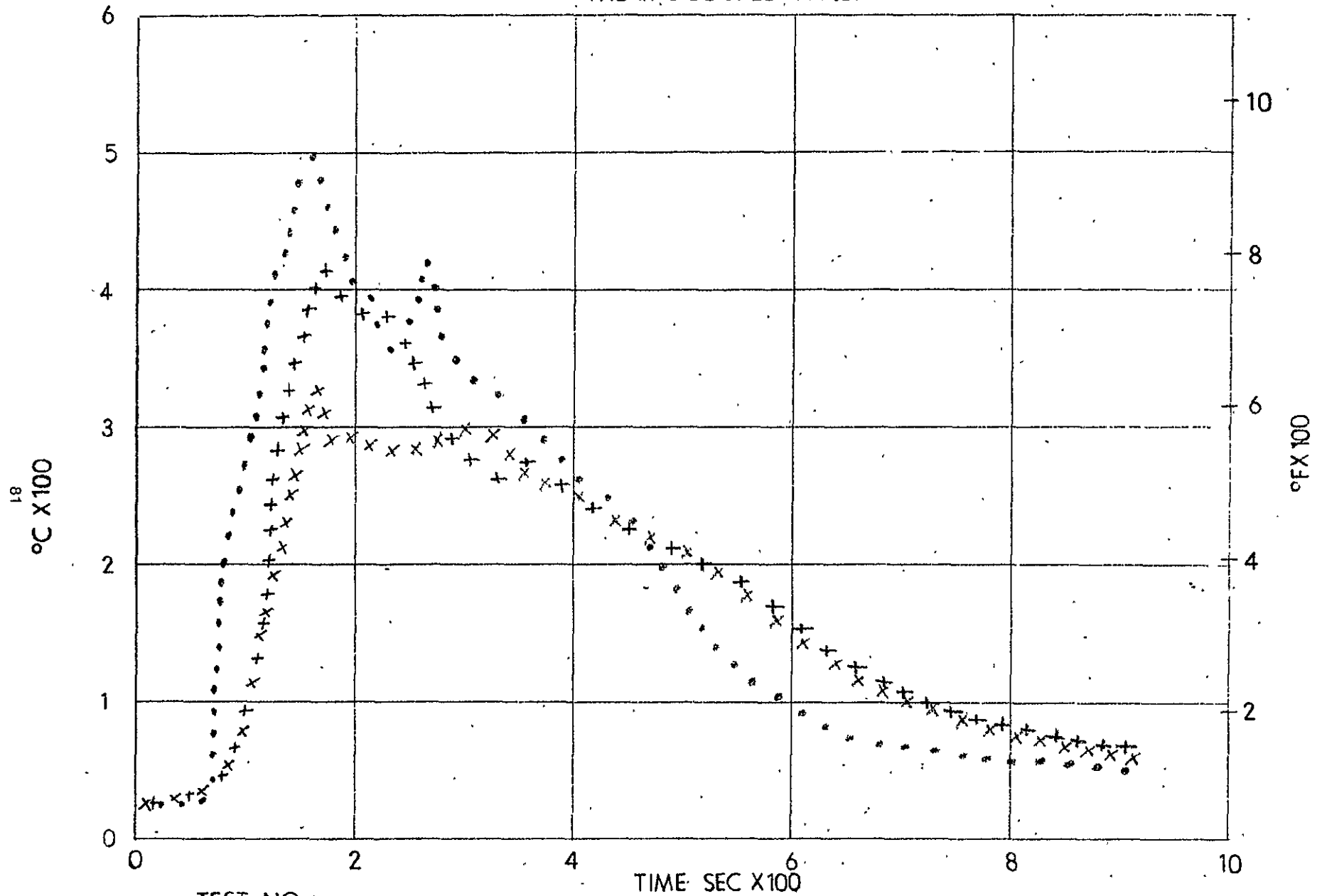
13. x x x

14. . . .

15. + + +

FIGURE NO. 48.
COMPARATIVE CURVES

THERMOCOUPLE NO.02



TEST NO :

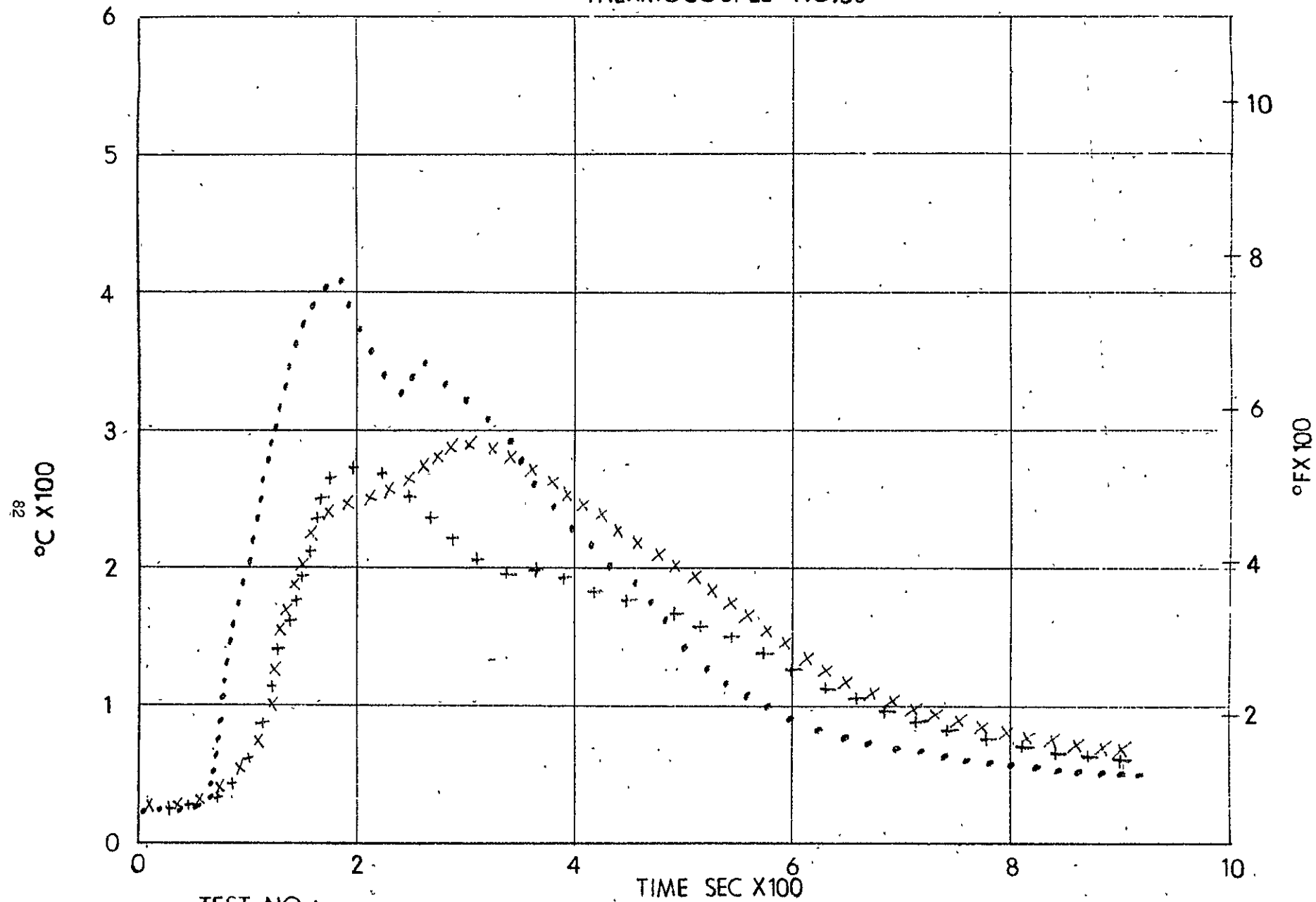
13 xxx

14 ooo

15 +++

FIGURE NO. 49
COMPARATIVE CURVES

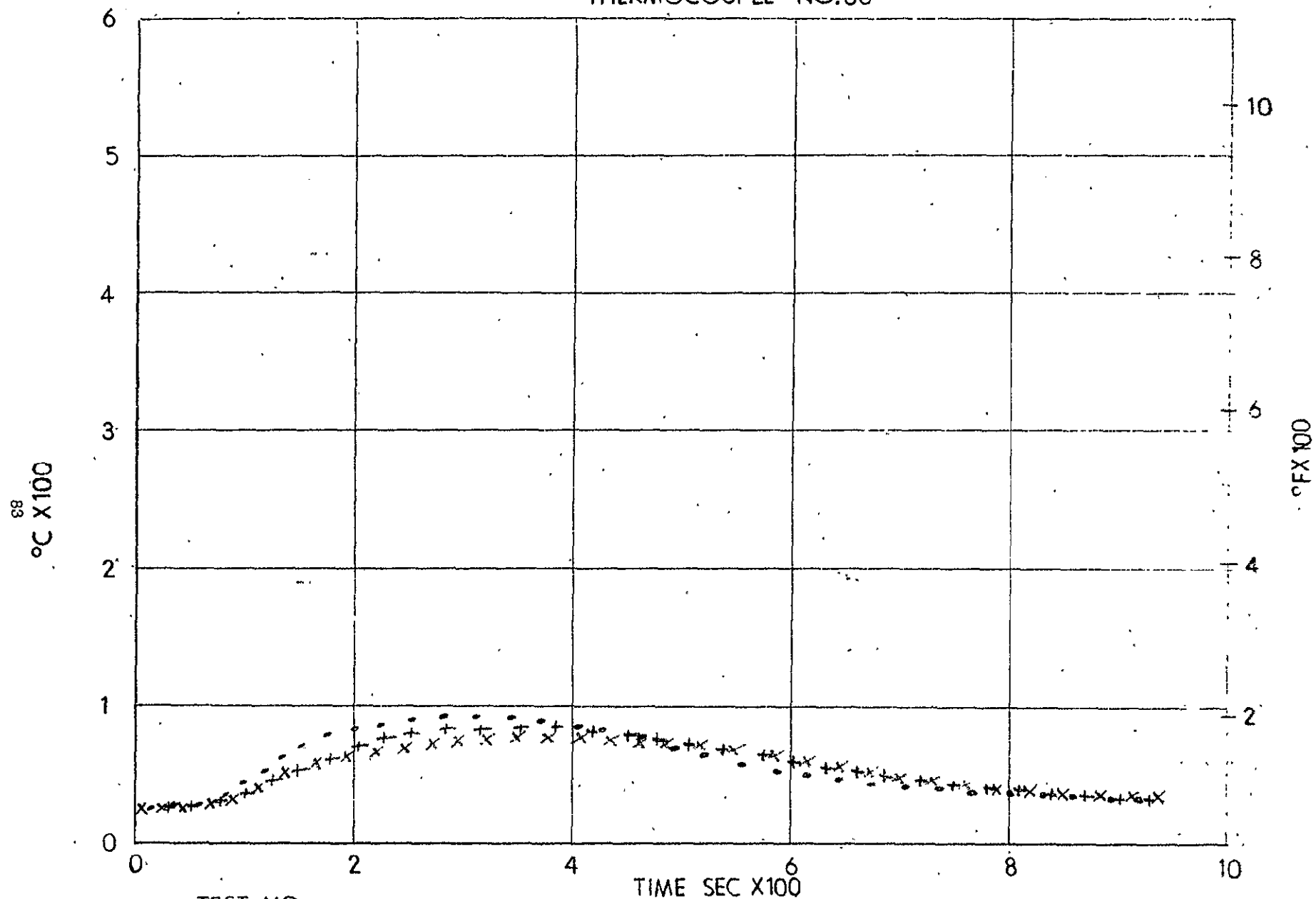
THERMOCOUPLE NO.03



TEST NO :
 13. xxx
 14. ooo
 15. +++

FIGURE NO. 50
 COMPARATIVE CURVES

THERMOCOUPLE NO.08



TEST NO :

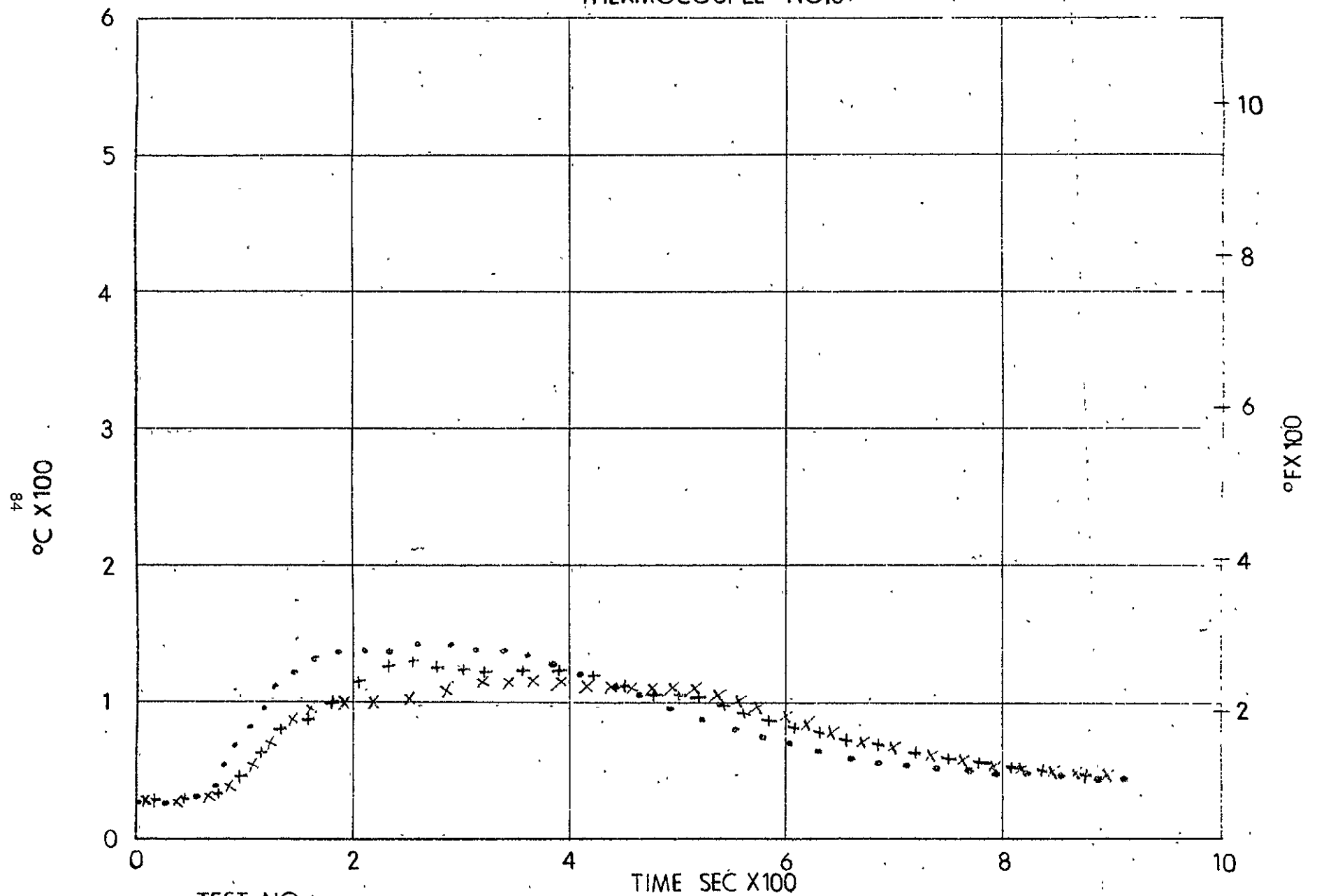
13 xxx

14 ooo

15 +++

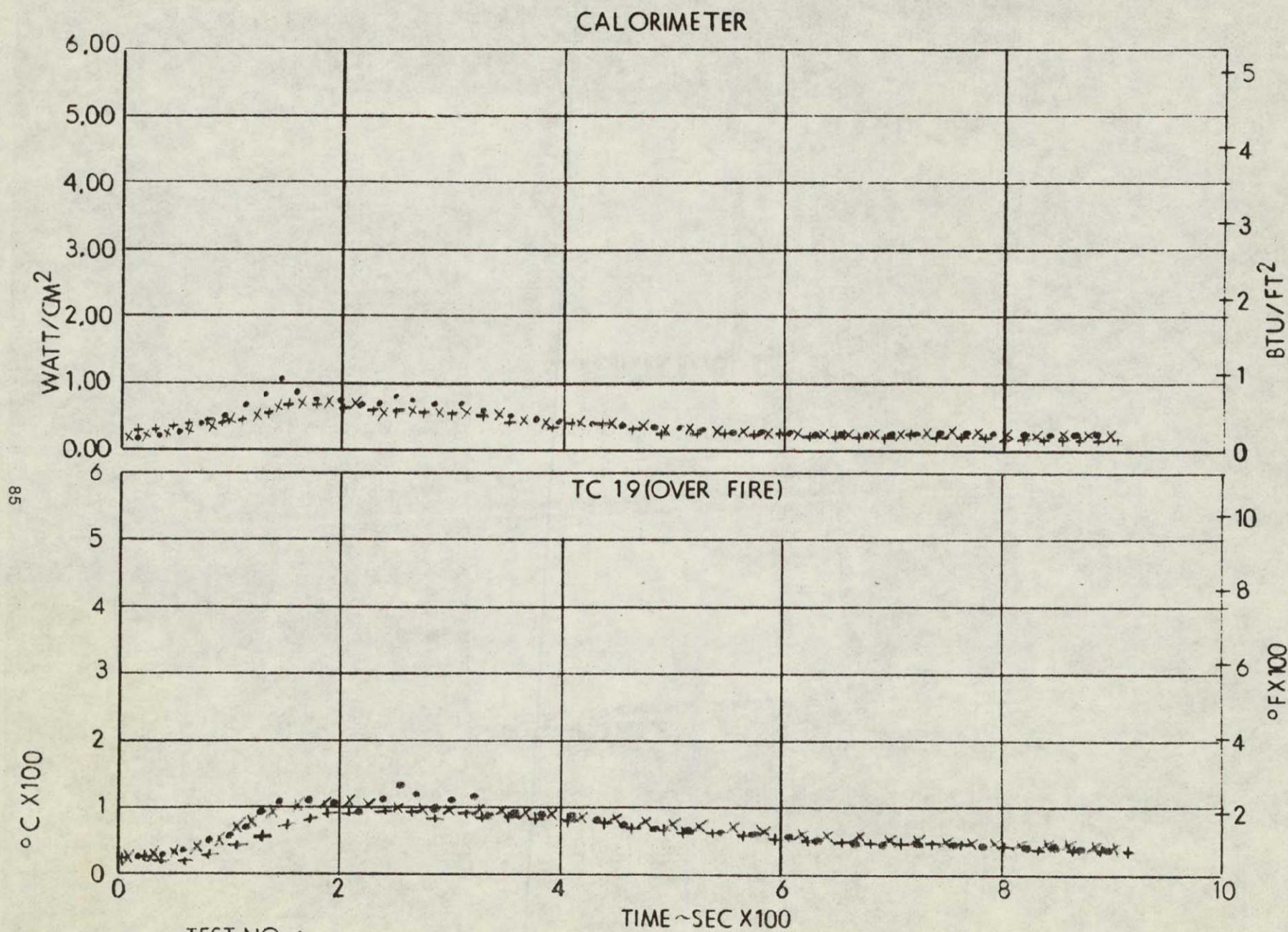
FIGURE NO. 51
COMPARATIVE CURVES

THERMOCOUPLE NO.09



TEST NO :
 13 xxx
 14 ooo
 15 +++

FIGURE NO. 52
 COMPARATIVE CURVES



TEST NO. :

13 xxx

14 ...

15 +++

FIGURE NO. 53
COMPARATIVE CURVES*

ORIGINAL PAGE IS
OF POOR QUALITY

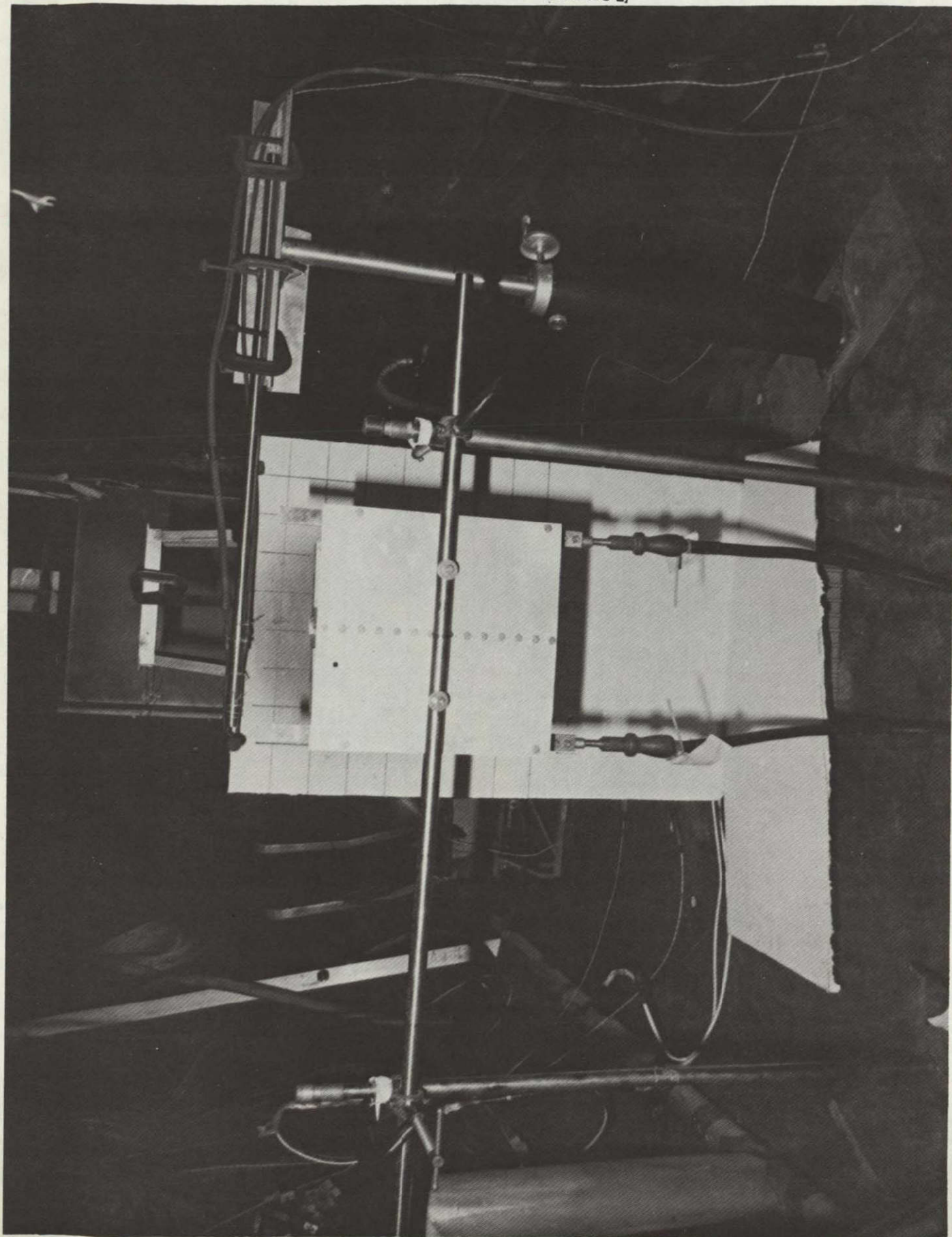
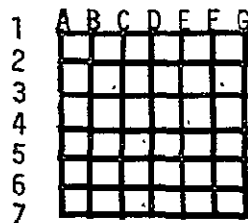


FIGURE 54. SET-UP FOR CALIBRATION OF RADIANT PANEL

TABLE X
CALIBRATION DATA FOR HEAT PANEL
POWER INPUT: 7000 WATTS
DISTANCE OF PANEL FROM GRID: RUN 1 - 12 INCH
RUN 2 - 6 INCH
RUN 3 - 18 INCH

GRID LOCATION	RUN NO			GRID LOCATION	RUN NO		
	1	2	3		1	2	3
A-1	0.62	0.50	0.43	E-1	0.85	0.83	0.52
A-2	0.74	0.82	0.49	E-2	1.04	1.67	0.64
A-3	0.80	1.06	0.54	E-3	1.26	2.38	0.69
A-4	0.83	1.21	0.55	E-4	1.35	3.17	0.71
A-5	0.76	1.06	0.53	E-5	1.26	2.53	0.69
A-6	0.66	0.80	0.47	E-6	1.01	1.65	0.64
A-7	0.56	0.54	0.44	E-7	0.77	0.85	0.53
B-1	0.76	0.64	0.50	F-1	0.78	0.73	0.51
B-2	0.89	1.27	0.58	F-2	0.94	1.40	0.61
B-3	1.04	1.84	0.62	F-3	1.15	2.01	0.66
B-4	1.08	2.25	0.64	F-4	1.23	2.57	0.66
B-5	1.00	1.95	0.63	F-5	1.14	2.16	0.64
B-6	0.87	1.22	0.57	F-6	0.91	1.38	0.59
B-7	0.66	0.72	0.51	F-7	0.70	0.74	0.48
C-1	0.84	0.78	0.53	G-1	0.67	0.57	0.46
C-2	1.05	1.63	0.64	G-2	0.80	0.96	0.58
C-3	1.23	2.37	0.69	G-3	0.95	1.37	0.61
C-4	1.34	3.13	0.70	G-4	1.00	1.62	0.61
C-5	1.25	2.55	0.70	G-5	0.92	1.45	0.61
C-6	1.01	1.57	0.62	G-6	0.77	0.99	0.54
C-7	0.75	0.85	0.56	G-7	0.61	0.61	0.45
D-1	0.87	0.84	0.54	ALL RECORDED VALUES ARE BTU/FT ² -SEC.			
D-2	1.06	1.73	0.66				
D-3	1.32	2.52	0.70				
D-4	1.44	3.34	0.73				
D-5	1.28	2.67	0.72				
D-6	1.06	1.70	0.63				
D-7	0.78	0.91	0.56				



EACH GRID IS THREE INCHES ON A SIDE.

It was decided prior to starting the test program, that the heat flux to be used in the tests should be between 1.5 and 3.5 in order to obtain a rough approximation of the heat flux used in the material selection tests.

The computer data, as shown in Appendix II, shows that for the heat panel tests the temperature rises as the power is applied to the panel, then a stabilized temperature profile is maintained until test termination. The fluctuation in the curves is believed to have been caused by the instability of the input power. Each series of curves is similar to the other series of curves with the variations in temperature readings caused by the distance of the panel away from the grid. No traces of Test No. 26A were obtained as the magnetic tape was destroyed during the data reduction process.

Even though a suitable range of heat-flux values was obtained, especially at the 6 inch distance, it is believed that the heat panel should not be used as the standard fire source for the following reasons:

- o Not a realistic onboard aircraft fire source.
- o Constant heat-flux which is not representative of a real fire condition.
- o The panel must be extremely close to the seat which could give unrealistic readings during the Phase III Test Program.
- o Due to the seat geometry, the heat panel gave a wide variation in readings. This was believed to have been caused by the heat rays not always striking the seat normal to the heat panel.

5.4 Conclusions and Recommendations

As a result of the information gained and the data obtained during this series of tests the following conclusions were reached:

- o Newspaper was the most prevalent item of clutter found on the aircraft.
- o The manner in which newspaper was folded and placed on the seat will determine the magnitude and duration of the resulting fire.
- o The newspaper when placed on the seat in the form of a tent will give a repeatable fire.
- o One and one-half pounds of newspaper will provide a more severe fire than a 3 pound load of newspaper.
- o The electric igniter will provide a consistent, repeatable ignition source.
- o The radiant heat panel will not provide as realistic a heat source as 1-1/2 pounds of newspaper.

Based on the conclusions reached, it is recommended that:

One and one-half pounds of newspaper, placed on the seat such that a tent is formed, be considered as the "standard fire" source for the Phase III test program.

6.0 Program Review

A program review was held at Douglas Aircraft Company, Long Beach, California on June 23, 1978. Attendees present at this review were as follows:

Bruns, Fred	Hardman Aircraft
Chase, William	Weber Aircraft
DuBovy, Pete	DAC - Government Marketing
Duskin, Fred	DAC - Interiors Engineering
Fewell, Larry	NASA-Ames
King, John	DAC - Advanced Engineering
Leland, John	DAC - Materials & Producibility Engineering
Lennert, Frank	DAC - Quality Assurance
Morford, Ralph	Toyad Corporation
Schjelderup, H.	DAC - Materials & Producibility Engineering
Shannon, Ray	DAC - Materials & Producibility Engineering
Shook, Bill	DAC - Interiors Engineering
Simon, Larry	Fairchild Burns Company
Trabold, Ed	DAC - Materials & Producibility Engineering

During the morning session, presentations were given as follows:

Program Overview	Larry Fewell, NASA Program Manager
Laboratory Testing of Seat Materials	Ed Trabold, DAC Materials Engineering
Seat Program, Phase III	Fred Duskin, Interiors Engineering

During the afternoon session an open discussion of the program was held between all attendees. All companies attending the review expressed a desire to become actively involved. They were concerned over the ability to judge comfort of the prototype seat cushions. Also needed, is further direction from NASA for the selection of materials and construction of the prototype burn test cushions. Fabrication of these cushions by the seat manufacturers will be accomplished under NASA contracts with the cushion materials provided as Government Furnished Equipment.

Overall, the program review achieved its basic goal to solicit the program participation of several seat manufacturers. As a follow-up of this review, NASA will write a letter to each of the interested companies outlining the details of their portion of the program.

7.0 Program Discussion

Considerable materials test data has been produced by this program. This data will provide the necessary materials information for the subsequent design phase. In the future this data will serve as a baseline to evaluate new materials when they become available.

Whenever a source fire is developed, for full scale burn testing, many questions arise relative to its validity. A satisfactory source fire must be repeatable and produce the desired thermal environment. For this program, the source fire was required to create a likely or reasonable fire threat level for an in-flight fire situation. The source fire development tests proved that we met this criteria. If a more severe fire threat were desirable, then it would be necessary to consider a post-crash scenario. This could be a future consideration if the performance of candidate materials are approximately equal for the conditions to be tested in Phase III.

The proposed Phase III program is a minimum test effort due to the economic limitations of the program. An enlarged program would permit the evaluation of additional material and design combinations. However, the matrix expands readily and it soon becomes obvious that practical program limitations must be implemented.

In reviewing the program we are encouraged by the results and recommend that Phase III be expeditiously pursued to maintain good program continuity.

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8.0 REFERENCES

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2. Contract NAS 2-9337, "Study to Develop Improved Fire Resistant Aircraft Seat Materials." NASA, Ames Research Center, Moffet Field, CA, September 20, 1976.
3. Trabold, E. L., "Study to Develop Improved Fire Resistant Aircraft Passenger Seat Materials Phase I," NASA CR-152056, Final Report, 119 pages.
4. Tesoro, G. and Moussa A., "Advanced Materials for the Development of Fire-Safe Aircraft Seats" Final Report Grant No. NSG-2204, Dec. 1977, 20 pages.
5. Comeford, J. J., Paabo, M., "A Study of Decomposition Products of Polyurethane Foam Related to Aircraft Cabin Flash Fires." FAA-RD-73-46, Federal Aviation Administration, July 1973, with modification of instructor McDonnell Douglas Engineering Report MDC J1686 (See Figure 1).
6. Spieth, H. H., "A Simple Animal Test for Evaluating Relative Toxicity," presented at the International Conference of Fire Safety held at the University of San Francisco, January 1976.
7. Gaume, J. G., Barter, P. and Rostami, H. J., "Experimental Results on Time of Useful Function (TUF) After Exposure to Mixtures of Serious Contaminates," Aerospace Medicine, 42 N00 987-990, September 1971.
8. Smith, E. E., "Measuring Rate of Heat, Smoke, and Toxic Gas Release," Fire Tech. 8, 237, 1972.
9. ASTM E 5.020.03, Heat Release Rate, Test Methods, "Draft of a Test for Heat and Visible Smoke Release Rates in Materials and Products," Revised, April 26, 1977.

APPENDIX I

Materials Test Results

Detailed test result tables for Phase II, Part I and Phase II, Part 2 together with miscellaneous test results are reported in this appendix.

FIGURE I-1. PART 1 - HRR TESTS

SAMPLE IDENTIFICATION	HEAT FLUX W/cm ²	TIME TO IGNITION sec.	FLAME TRAVEL RATE mm/sec.	HEAT RELEASE KW - MIN./m ²					SMOKE RELEASE SSU/m ²				
				MAX. KW/m ² at sec.	TIME INTERVAL - MINUTES				MAX. SSU/m ² at sec.	TIME INTERVAL - MINUTES			
					1.5	3.0	5.0	10.0		1.5	3.0	5.0	10.0
SAMPLE 1	3.5	<5	>30	31.4 @ 32 sec.	41	66	112	225	28.3 SSU/m ² min. @ 34 sec.	7.7	10.4	22.8	38
SAMPLE 2	3.5	<5	>30	30.0 @ 19 sec.	40	62	109	205	20.1 per m ² , min @ 30 sec.	6.9	8.4	24.8	39.5
SAMPLE 3	3.5	<5	>30	33.0 @ 19 sec. 42.6 @ 295 sec.	36	60	129	302	48.6 SSU/m ² min. @ 379 sec.	5.3	12.7	78.3	222
SAMPLE 4	3.5	<5	>30	25.8 @ 30 sec. 53.6 @ 414 sec.	17	27	53	269	64.7 SSU per m ² min @ 408 sec.	0.6	2.4	52.3	235
SAMPLE 5	3.5	<5	>30	34.2 @ 32 sec.	12	27	60	131	9.9 SSU per m ² , min @ 154 sec.	3.0	7.3	9.7	29.5
SAMPLE 6	3.5	<5	>30	33.3 @ 19 sec.	26	45	89	206	13.1 SSU per m ² , min @ 444 sec.	1.8	8.4	19	58.6
SAMPLE 7	3.5	<5	>30	31.8 @ 17 sec. 51 @ 390 sec.	35	50	112	296	70 SSU per m ² , min @ 374 sec.	5.5	10.2	71.7	252
SAMPLE 8	3.5	<5	>30	21.0 @ 38 sec.	22	37	62	123	20.9 SSU per m ² , @ 38 sec.	8.4	8.9	19.5	39.3
SAMPLE 9	3.5	<5	>30	12.8 @ 48 sec.	22	34	56	108	18.7 SSU per m ² , min @ 314 sec.	6.1	6.3	26.3	51.1
BASELINE SAMPLE 10	3.5	<5	>30	88.2 @ 22 sec.	99	212	319	438	40.9 SSU per m ² , min @ 34 sec.	36.7	61.6	79.2	112.5

FIGURE I-2. PART 2 - HRR TESTS

SAMPLE IDENTIFICATION	HEAT FLUX W/cm ²	TIME TO IGNITION sec.	FLAME TRAVEL RATE mm/sec.	HEAT RELEASE KW - MIN./m ²					SMOKE RELEASE SSU/m ²				
				MAX. KW/m ² at sec.	TIME INTERVAL - MINUTES				MAX. SSU/m ² at sec.	TIME INTERVAL - MINUTES			
					1.5	3.0	5.0	10.0		1.5	3.0	5.0	10.0
SAMPLE 11 Smoke 0-100%/FS	20 mu/ FS 3.5	<5	~7.6	75.4 @ 22 sec.	81.8	152	276	401	57.6 SSU per m ² min. @ 30 sec.	30.4	48.9	69.8	106.4
SAMPLE 12 0-100%/FS	10 mu/ FS 3.5	<5	~10.6	23.9 @ 19 sec.	31.5	46.1	75	149	11.2 SSU per m ² min @ 19 sec.	12.0	22.5	39.1	73.5
SAMPLE 13 0-100 %/FS	10 MU/ FS 3.5	<5	~7.6	31.2 @ 19 sec. 70 @ 540 sec.	36.6	66.6	144	433	78.5 SSU per m ² , min @ 528 sec.	16.1	34.3	103.9	366.5
SAMPLE 14 0.4 OD	3.5	<5	~5.8	60 @ 19 sec 34.8 @ 924 sec.	65	85.9	107	204	5.8 SSU per m ² , min @ 850 sec.	7.7	9.5	11.3	27.8
SAMPLE 15 0.4 OD	10 MU/ FS 3.5	<5	~6.6	66 @ 24 sec 38.4 @ 1015 sec.	41.6	57	75.8	136	5.4 SSU per m ² , min. @ 869 sec.	4.2	4.5	5.5	10.2
SAMPLE 16 0.4 OD	10 MU/ FS 3.5	<5	~6.7	55.8 @ 17 sec. 66.8 @ 787 sec.	56.9	74.1	93.2	220	7.3 SSU per m ² min. @ 706 sec.	4.5	5.4	7.6	50.9
SAMPLE 17 0-100%/FS	20 MU/ FS 3.5	<5	~11.1	25.0 @ 19 sec.	28.7	53.2	79.1	118	21.5 SSU per m ² min @ 154 sec.	13.2	29.1	43.3	76.8
SAMPLE 18 0-100%/FS	20 MU/ FS 3.5	<5	~10.6	31.2 @ 19 sec. 64.8 @ 547 sec.	30.1	48.8	121	438	61.4 SSU per m ² min @ 468 sec.	13.2	26.5	89.5	357
SAMPLE 19 0.4 OD	10 MU/ FS 3.5	<5	~8.8	76.8 @ 22 sec. 28.8 @ 166 sec.	47.7	73.8	101	183	3.9 SSU per m ² min @ 163 sec.	4.5	10.0	11.9	12.7
SAMPLE 20 0.3 OD	10 MU/ FS 1.5	<5	~8.8	41.4 @ 85 sec.	25.7	57.6	72.1	---	9.7 SSU per m ² min @ 77 sec.	2.9	5.3	---	---

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[illegible]

FIGURE I-4.

SAMPLE IDENTIFICATION	HEAT FLUX W/cm ²	TIME TO IGNITION sec.	FLAME TRAVEL RATE mm/sec.	HEAT RELEASE KW - MIN./m ²					SMOKE RELEASE SSU/m ²				
				MAX. KW/m ² at sec.	TIME INTERVAL - MINUTES				MAX. SSU/m ² at sec.	TIME INTERVAL - MINUTES			
					1.5	3.0	5.0	10.0		1.5	3.0	5.0	10.0
NON-PILOTED L.S. NEOPRENE 0.4 OD/FS	10 MU/ FS 2.5	---	NONE	NONE	7.6	14.7	21	34 (8 min)	0.6 SSU per m ² min @ 24 sec.	0.6	1.5	1.8	---
L.S. NEOPRENE 0.4 OD	10 MU/ FS 2.5	139 Flashes	Flashes only	4Kw @ 154 sec.	6.9	18.6	30.8	52.7 (8 min)	0.6 SSU Per M ² , min 19 sec.	1.3	1.6	2.4	---
L.S. NEOPRENE 0.4 OD	10 MU/ FS 5.0	9	>10	28.2 @ 79 sec.	40.3	73.7	87.4	108	21.3 SSU per m ² , min @ 22 sec.	72	87.6	84.8	---
L.S. NEOPRENE 0.1 OD/FS	10 MU/ FS 3.5	~12	5	22.4 @ 130 sec.	28.6	71	100	103	14.6 SSU per m ² min @ 14 sec.	8.7	31.3	33.9	---

FIGURE I-5.

SAMPLE IDENTIFICATION	HEAT FLUX W/cm ²	TIME TO IGNITION sec.	FLAME TRAVEL RATE mm/sec.	HEAT RELEASE KW - MIN./m ²					SMOKE RELEASE SSU/m ²				
				MAX. KW/m ² at sec.	TIME INTERVAL - MINUTES				MAX. SSU/m ² at sec.	TIME INTERVAL - MINUTES			
					1.5	3.0	5.0	10.0		1.5	3.0	5.0	10.0
SAMPLE 309 SILICONE 9FR 618 SPONGE	3.5	<5	>30	88.5 @ 132 sec.	76.7	215	331	430	~40 per m ² min @ 130 sec.	~39	~84	~86	-
	5.0	<5	>30	98.8 @ 120 sec.	90.9	205	311	370 (9.5 min.)	37.2 per m ² , min @ 17 sec.	47.5	75.9	72.3	-
	2.5	<5	>10	79.3 @ 106	38.1	162	272	343	~21 per m ² , min @ 103 sec.	7.1	12.6	41.6	49.2
	3.5	<5	>30	72.2 @ 74	57.6	183	335	421 (9.8 min)	39.6 per m ² min. @ 132 sec.	31.8	80.6	111	-

FIGURE I-6.

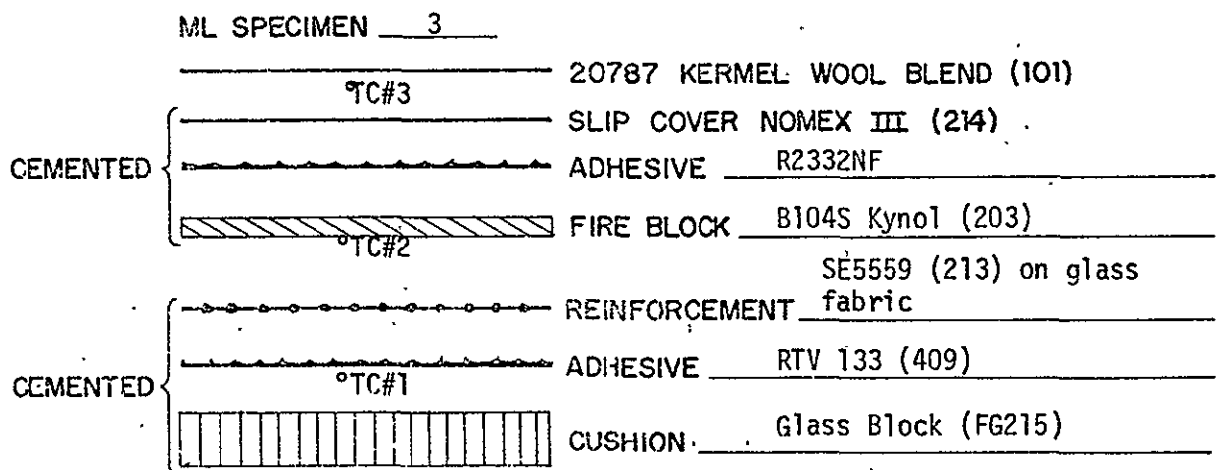
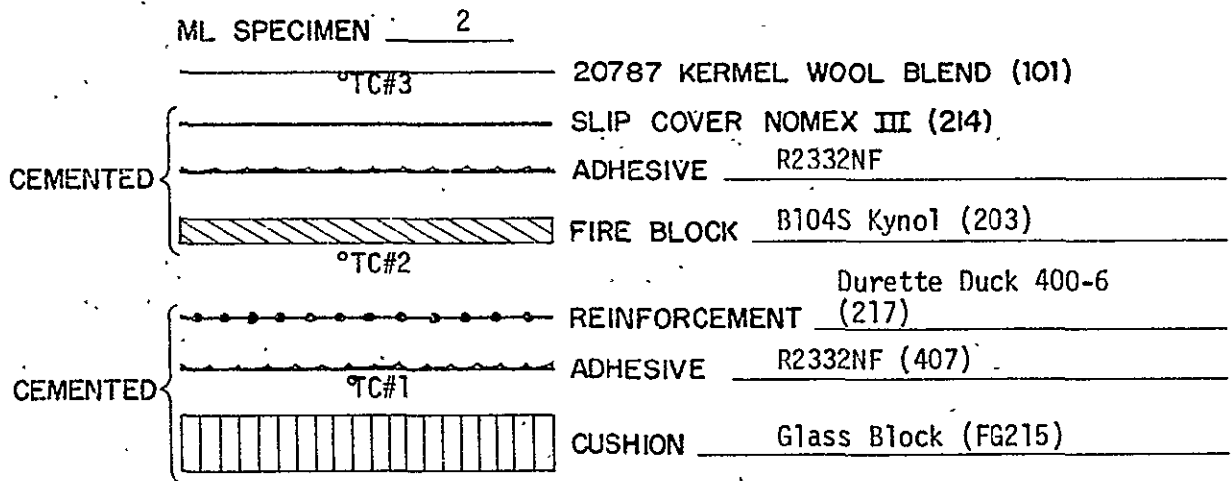
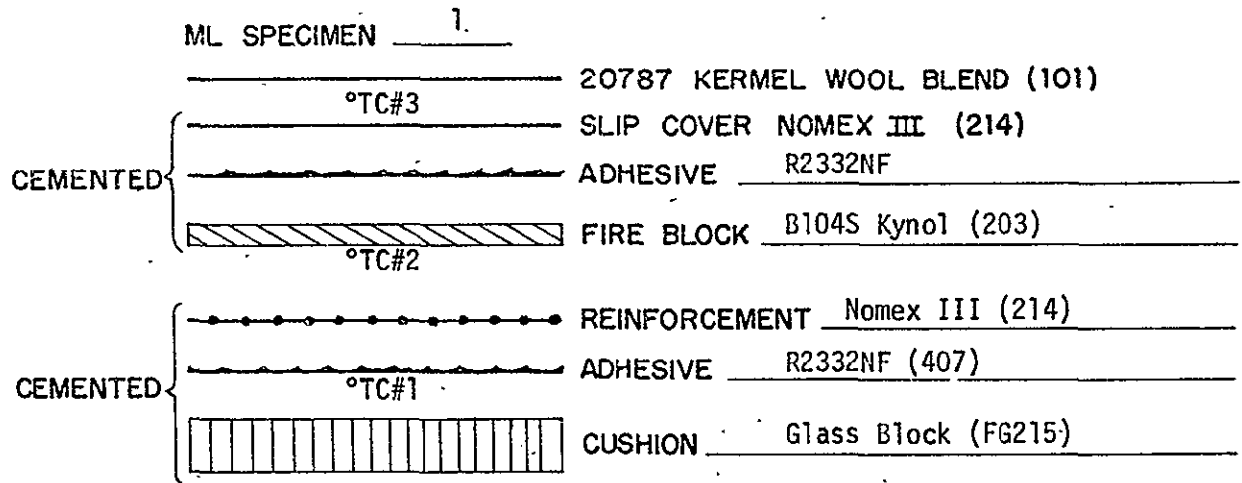


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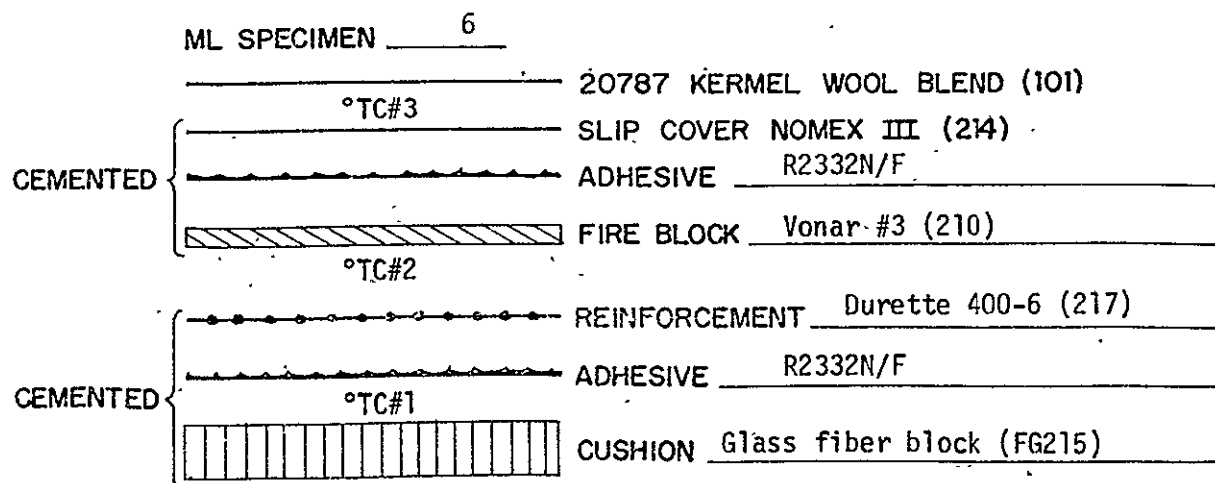
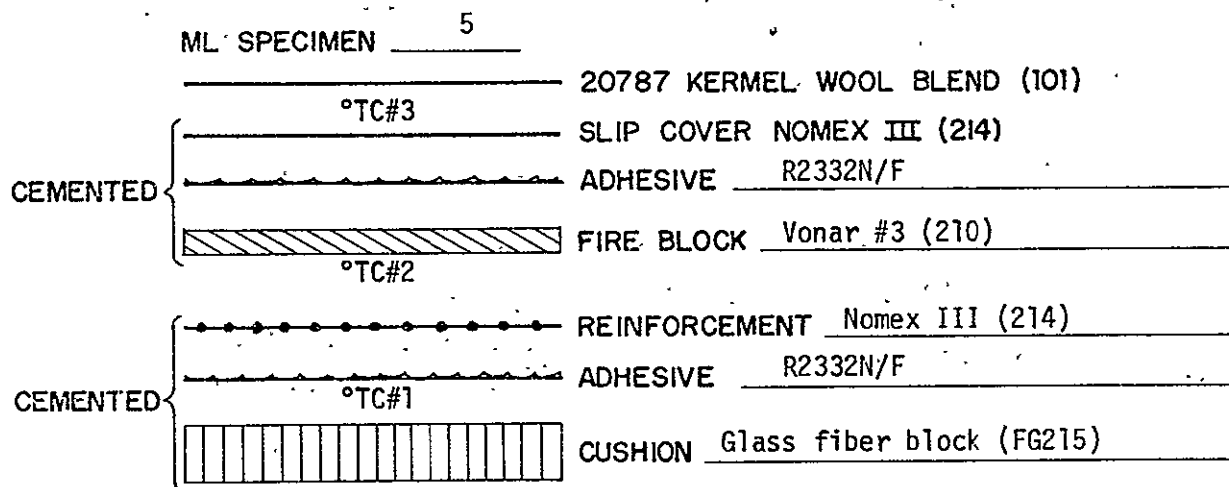
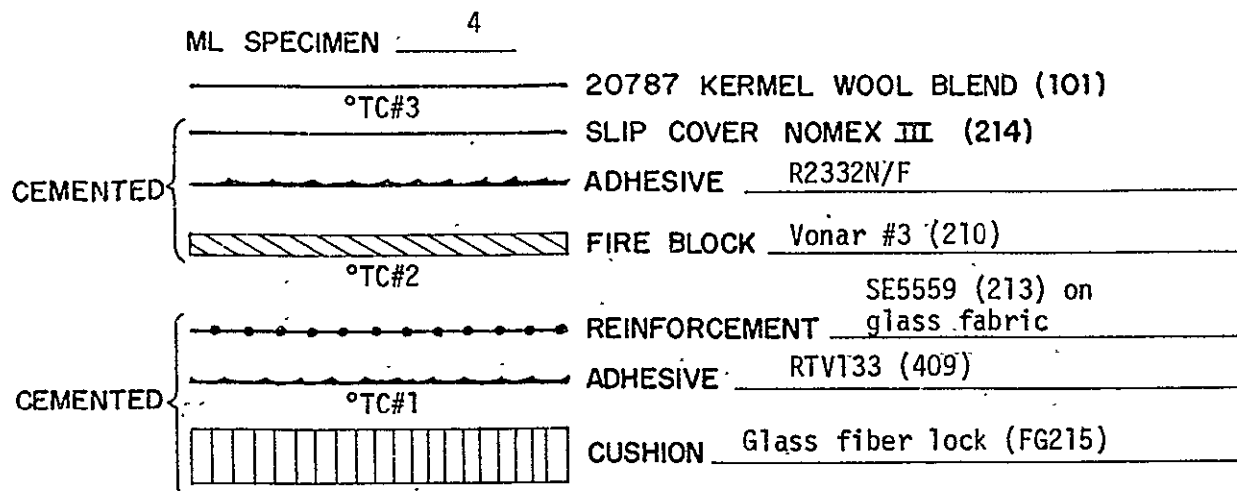


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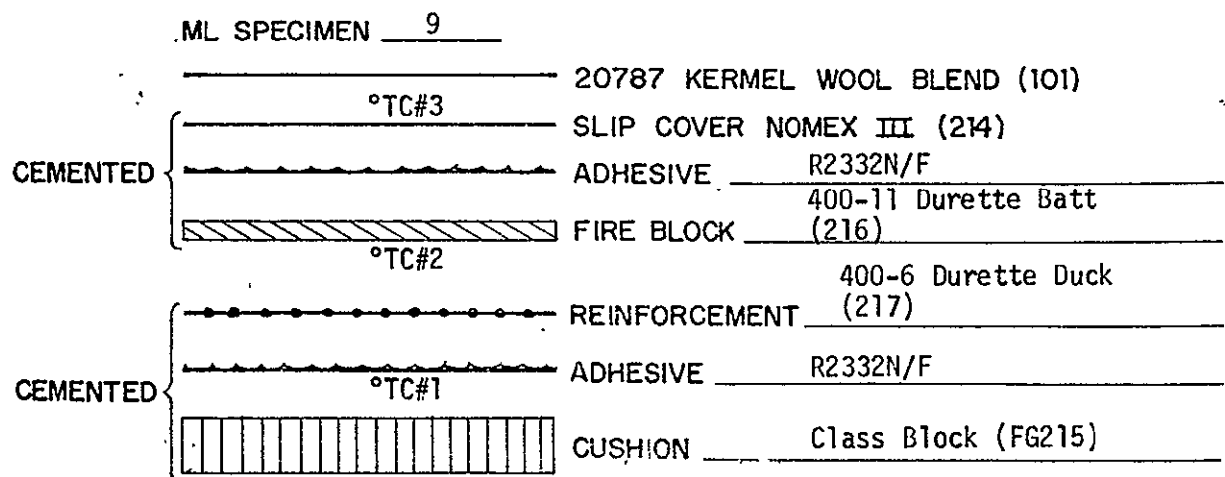
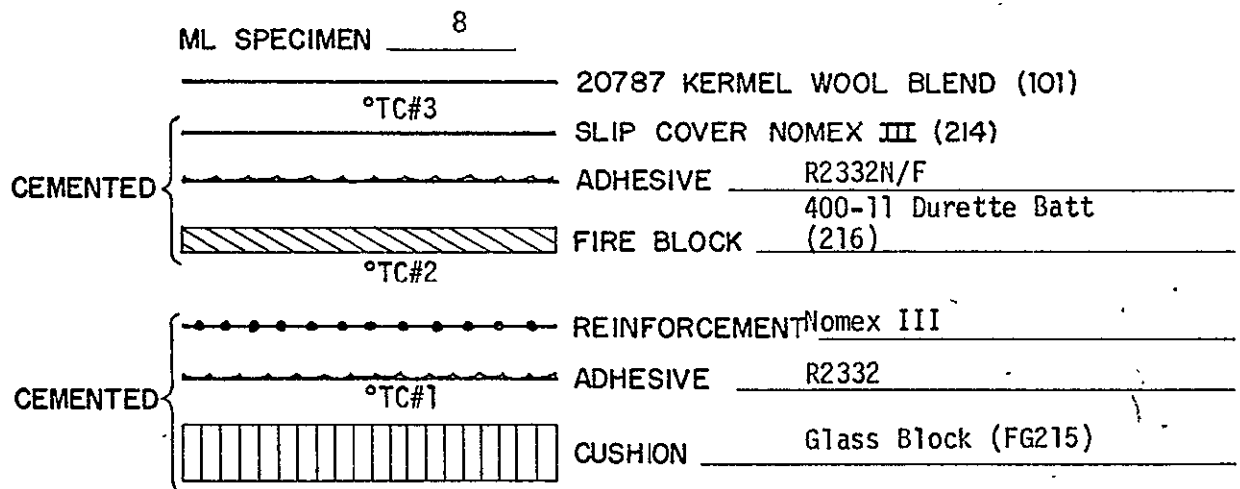
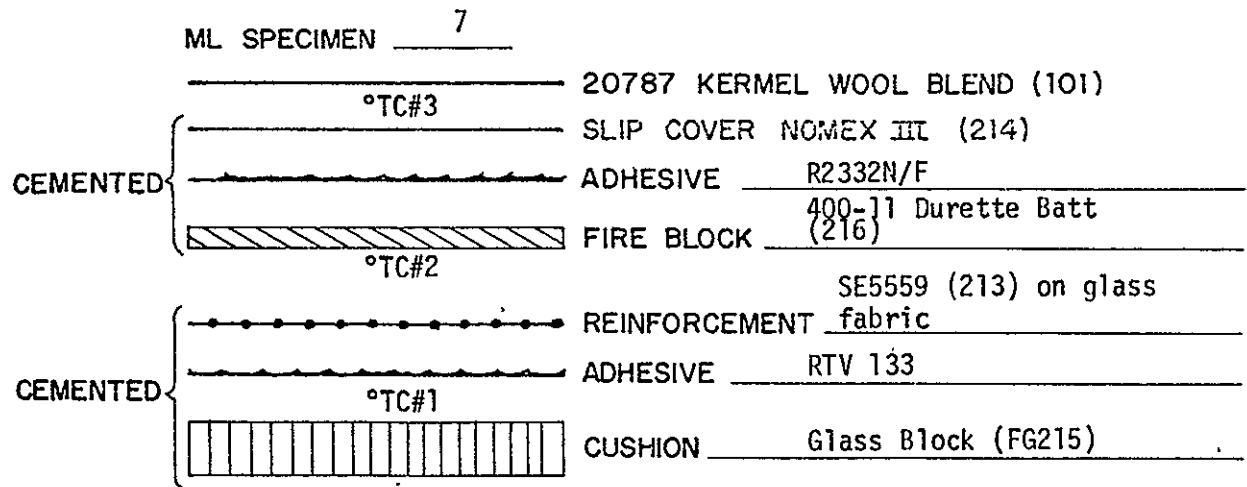


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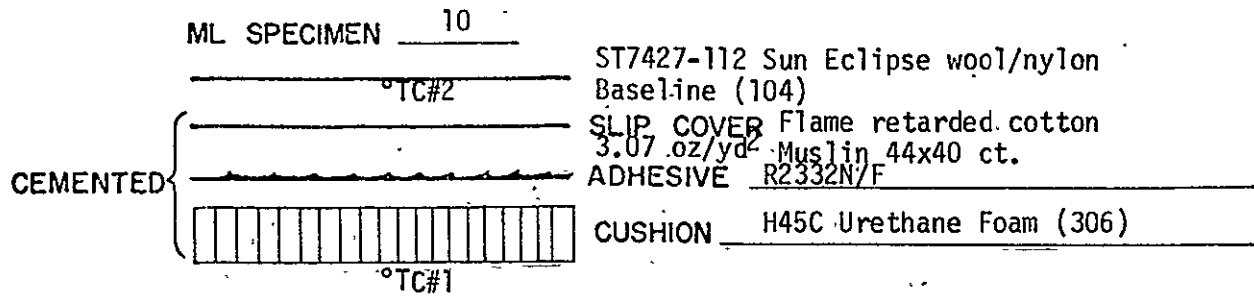


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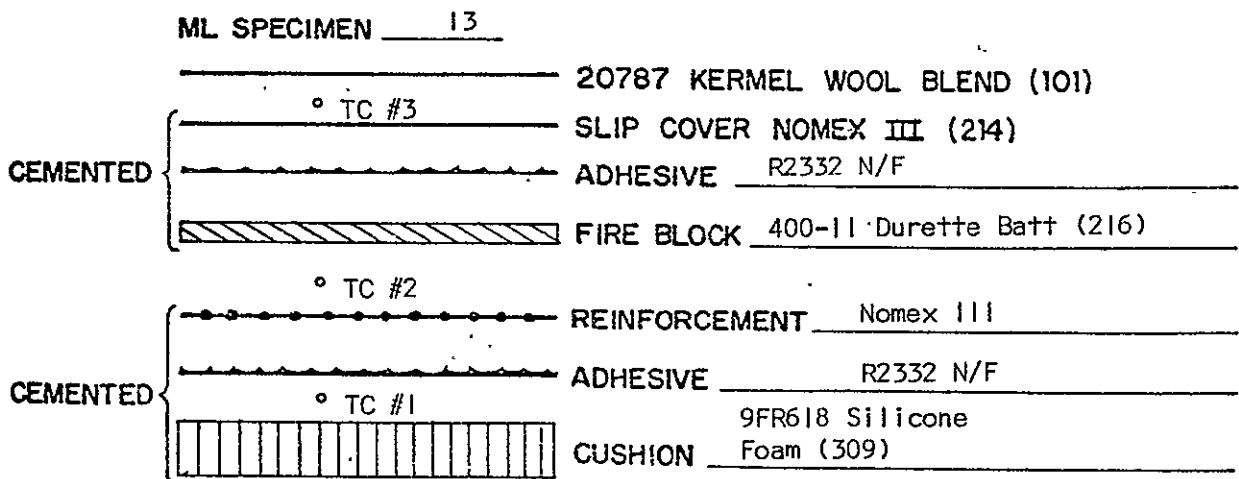
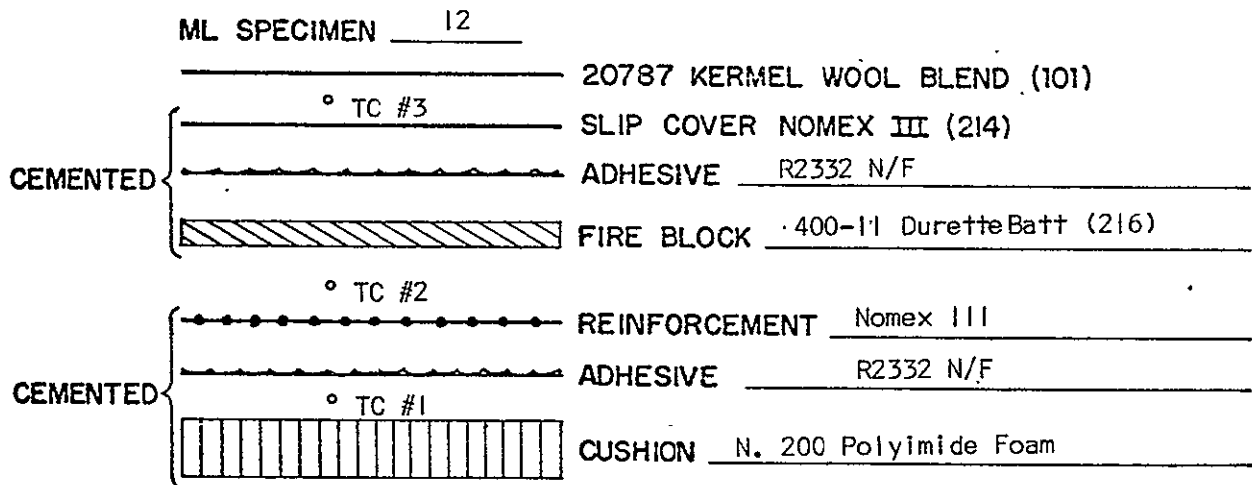
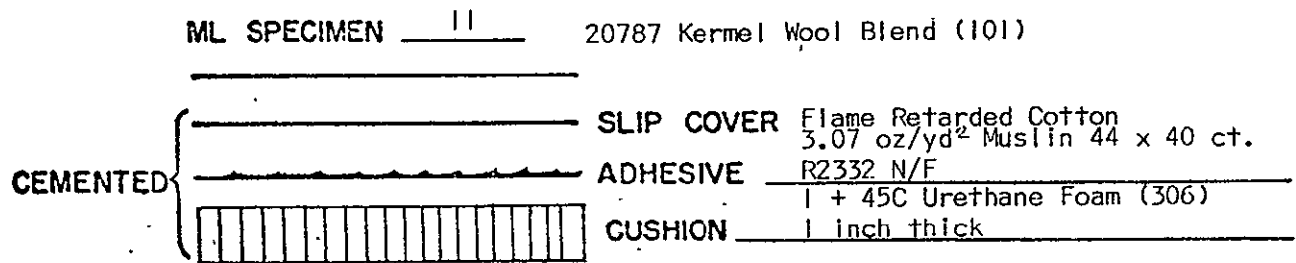
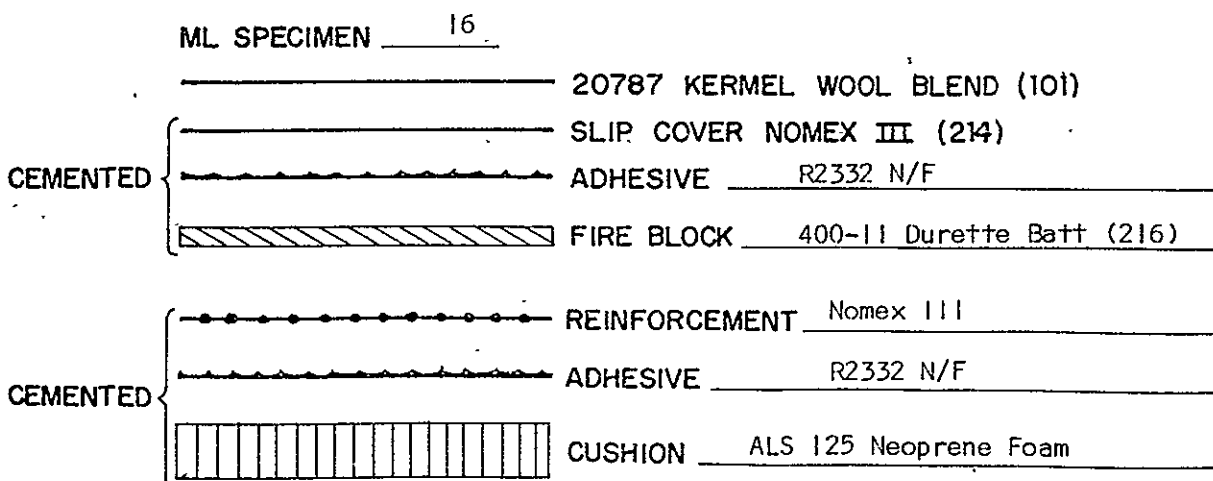
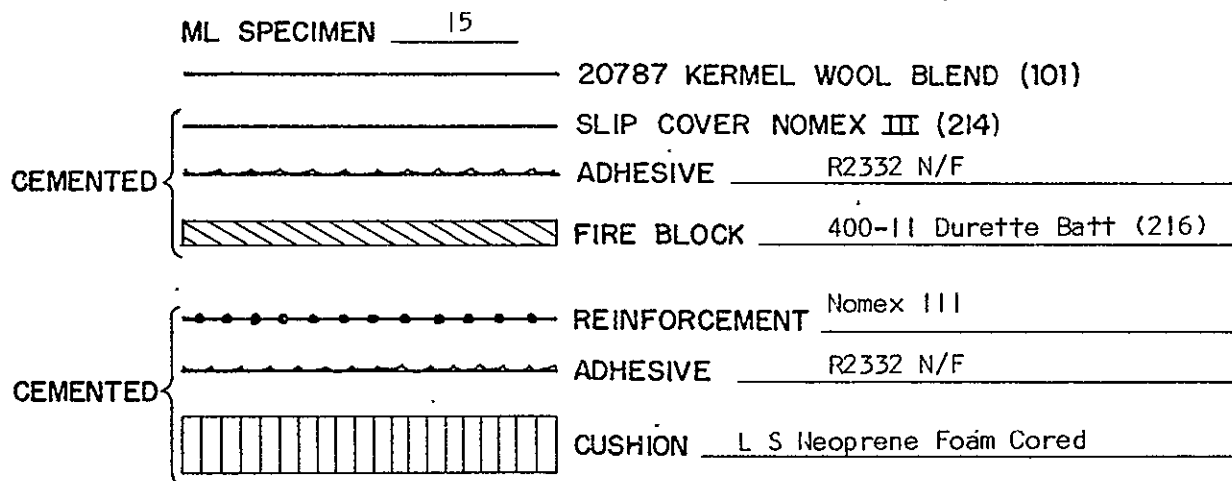
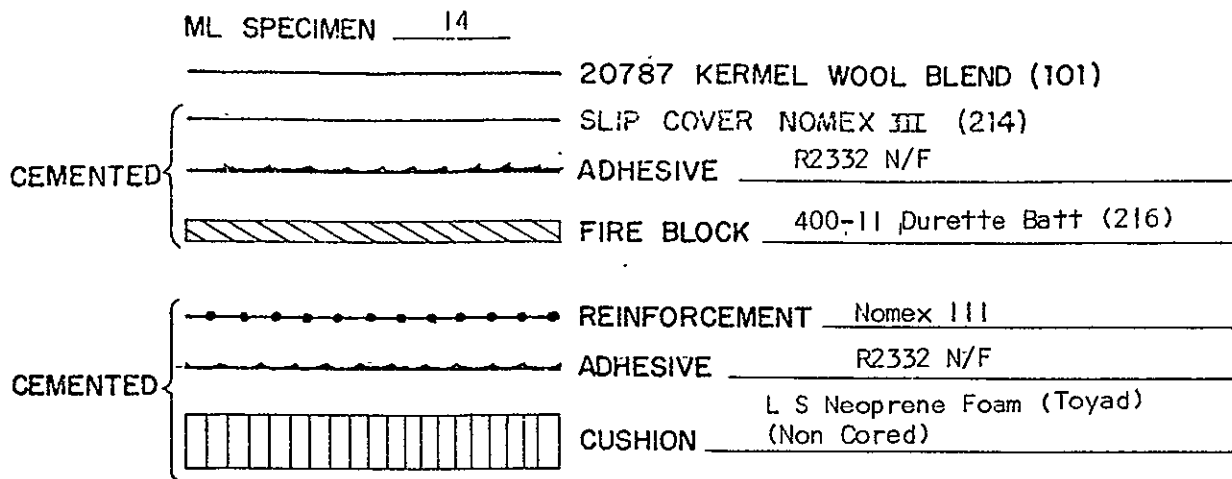
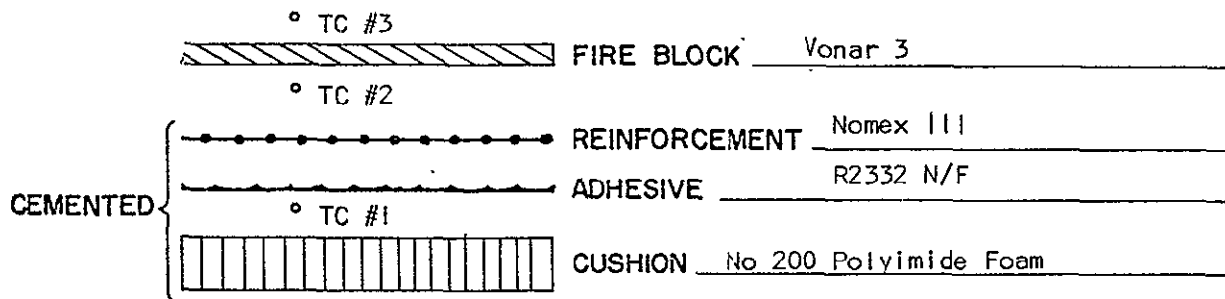


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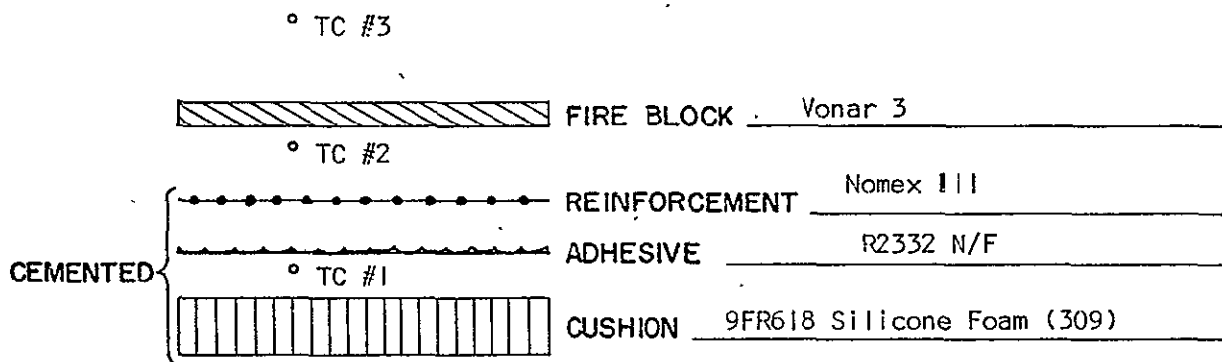
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20787 KERMEL WOOL BLEND (101)



ML SPECIMEN 18

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ML SPECIMEN 19

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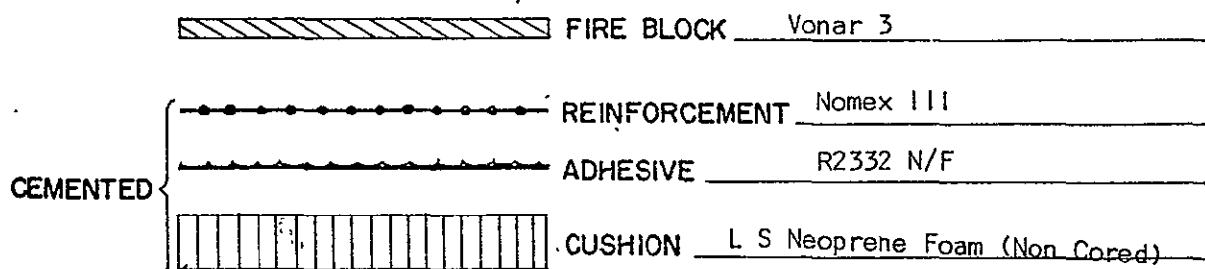
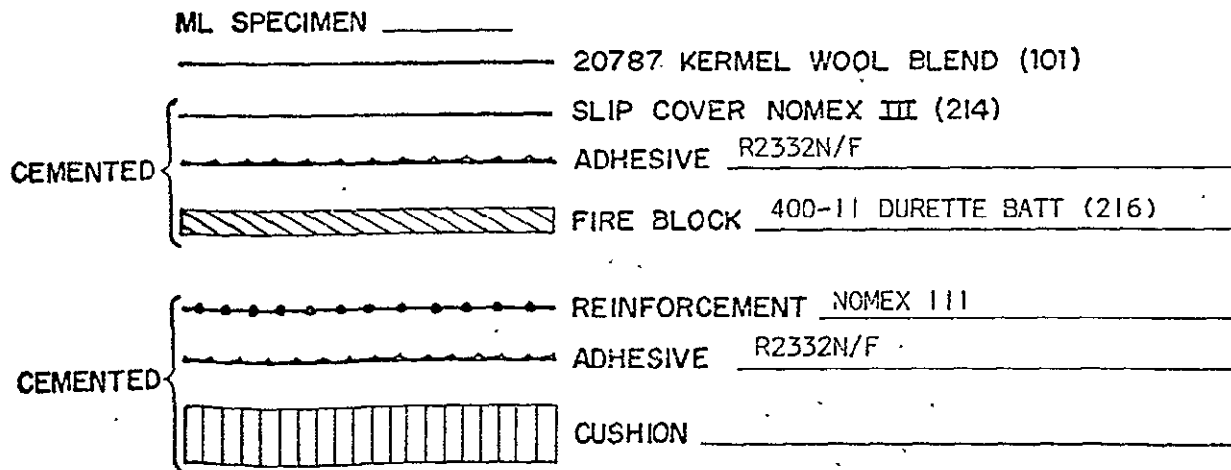
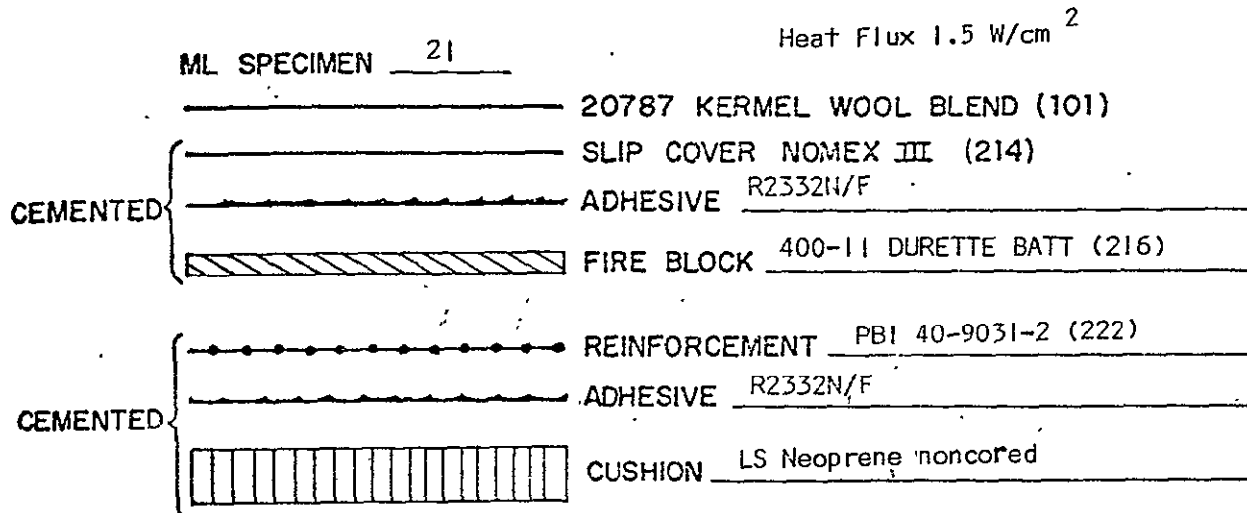
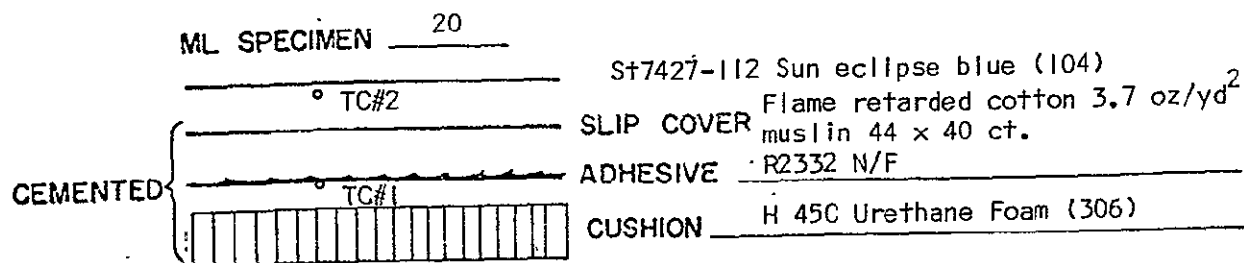
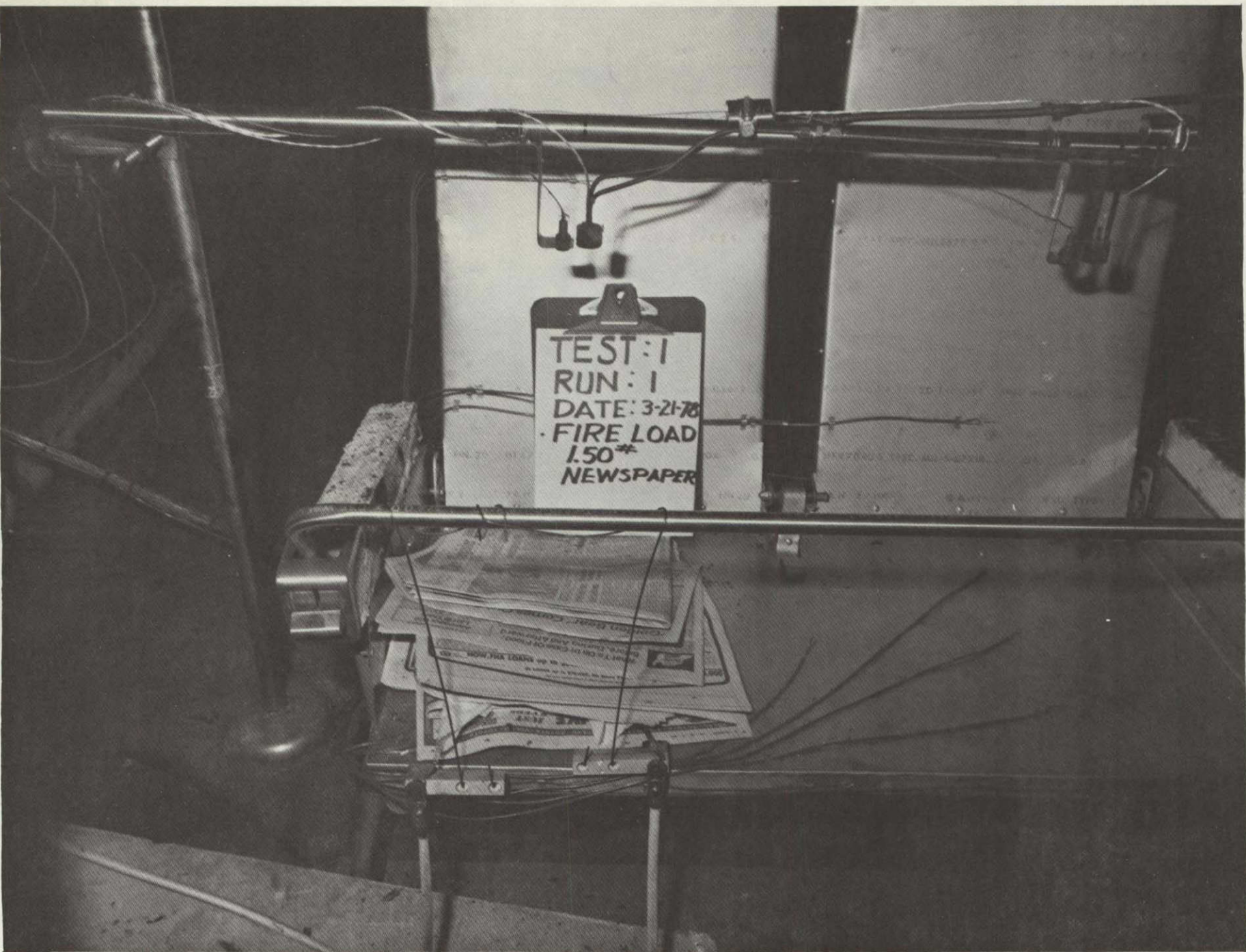


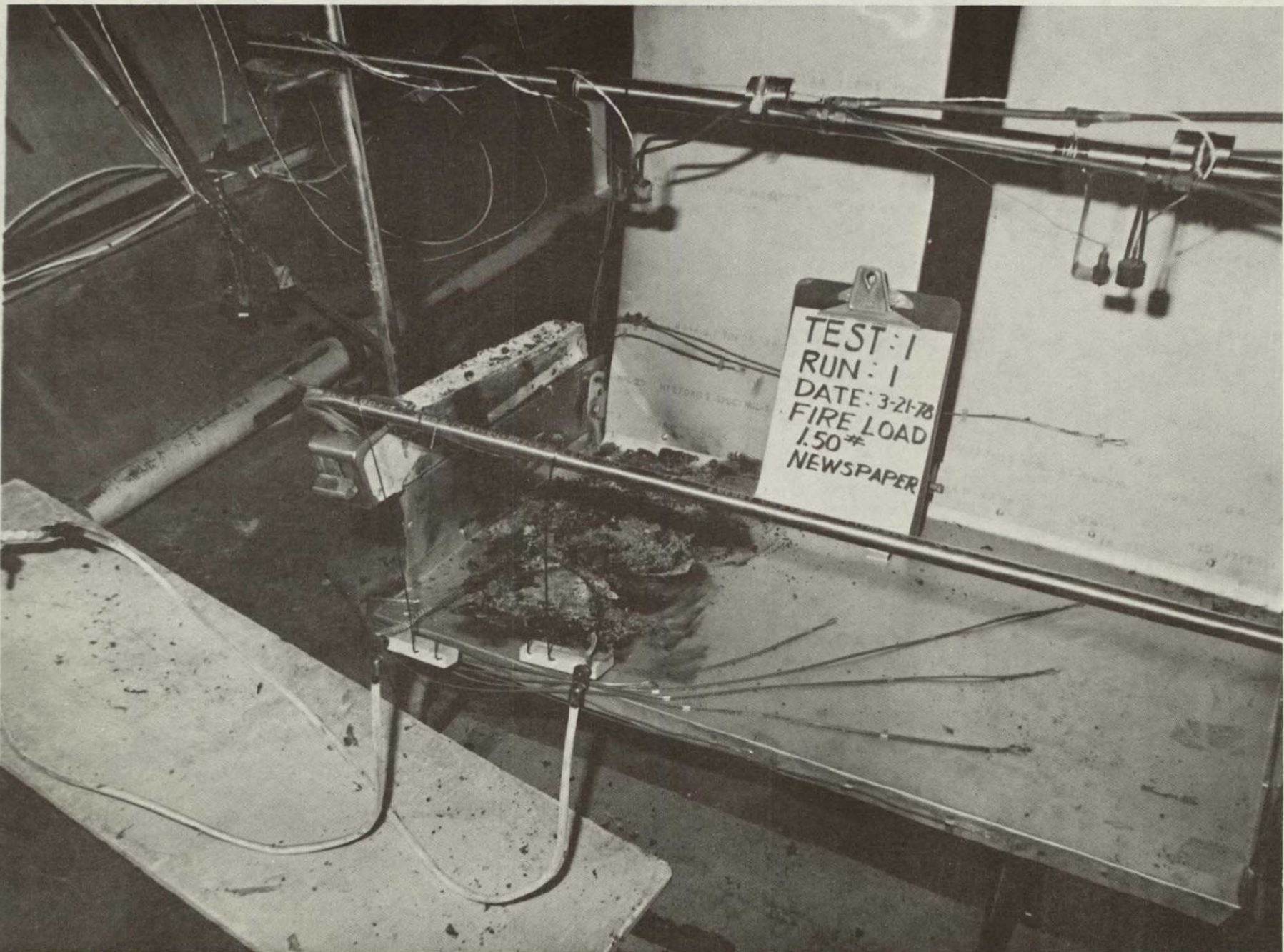
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APPENDIX II
SOURCE FIRE TEST PHOTOS



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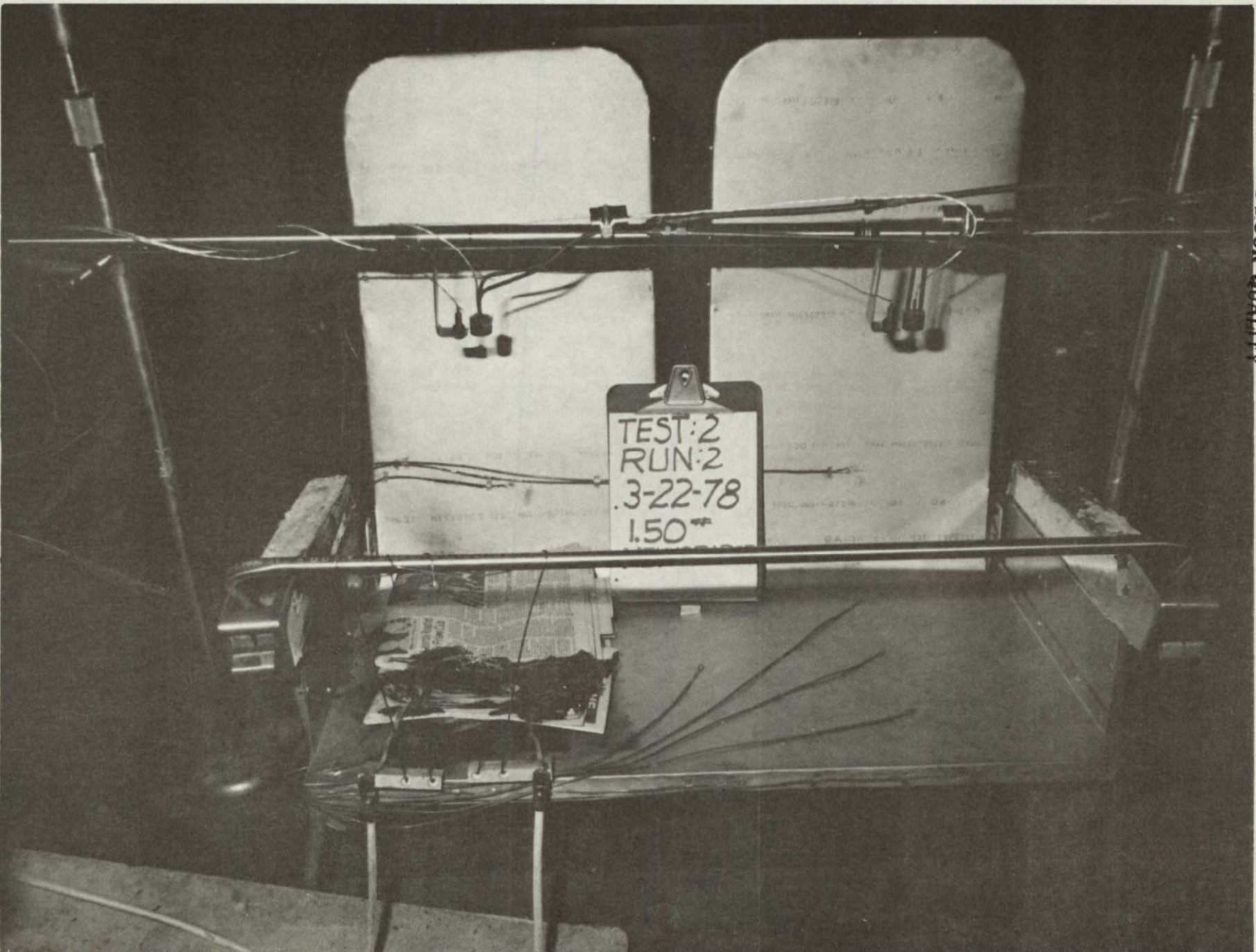


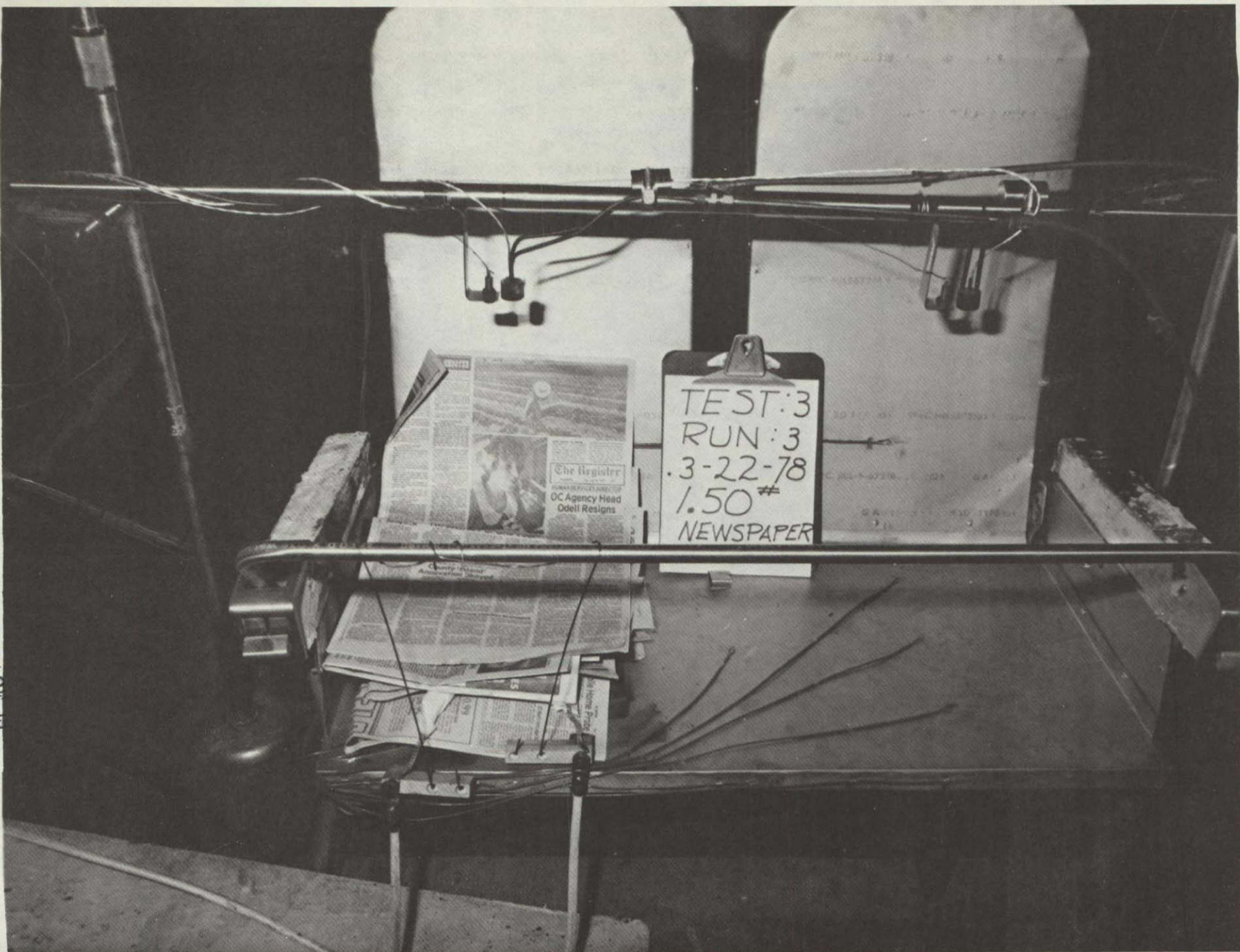
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By Fred C. ...

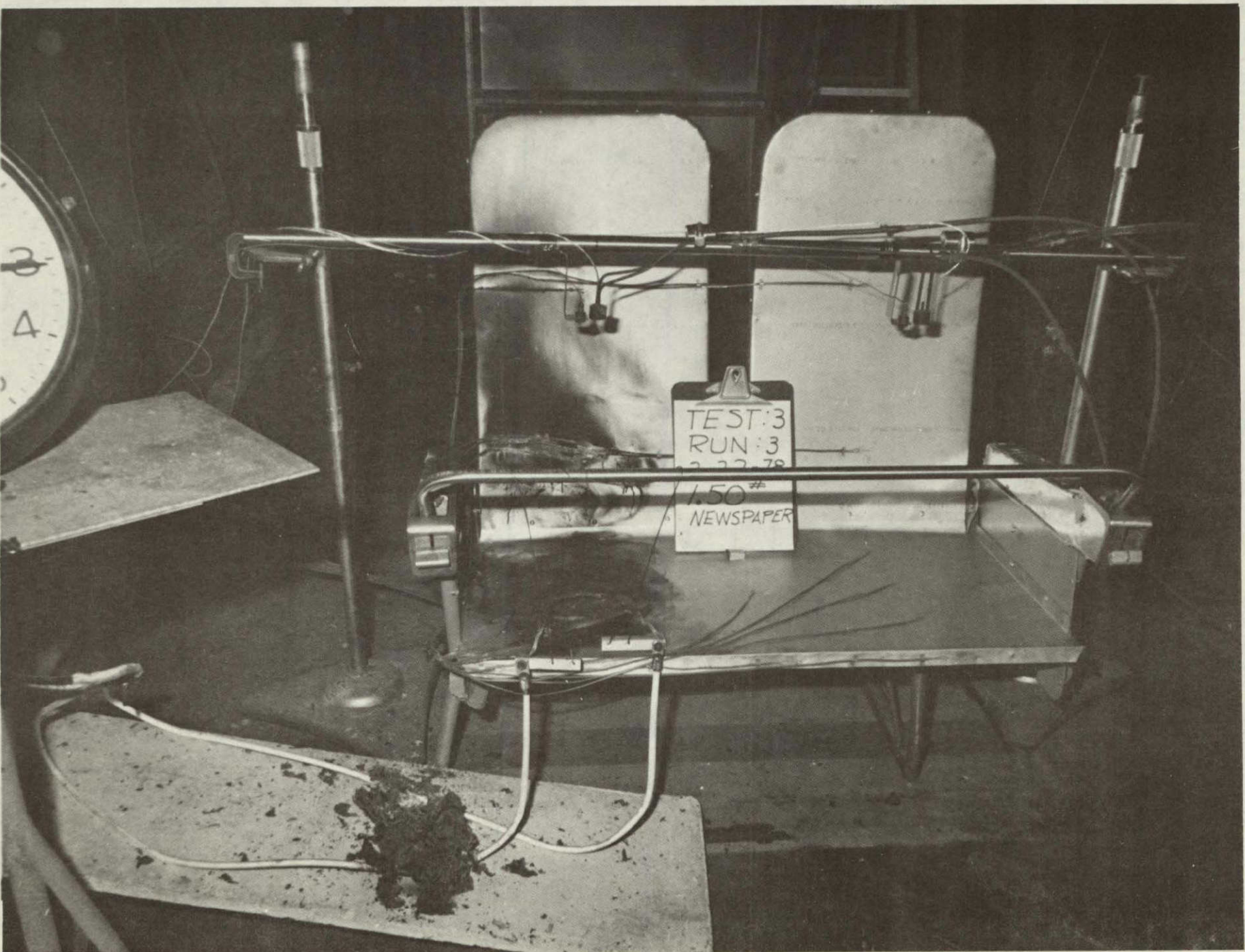
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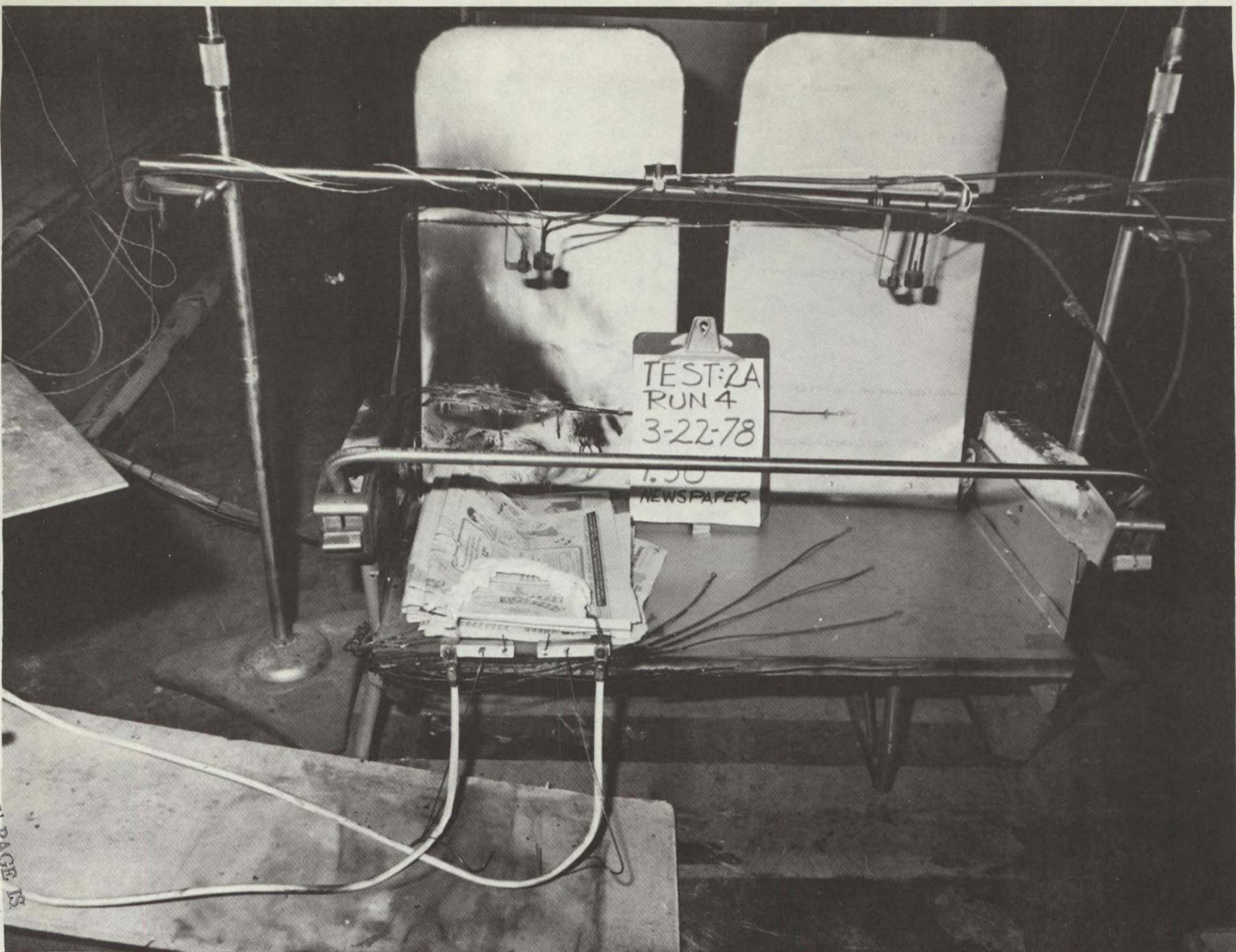
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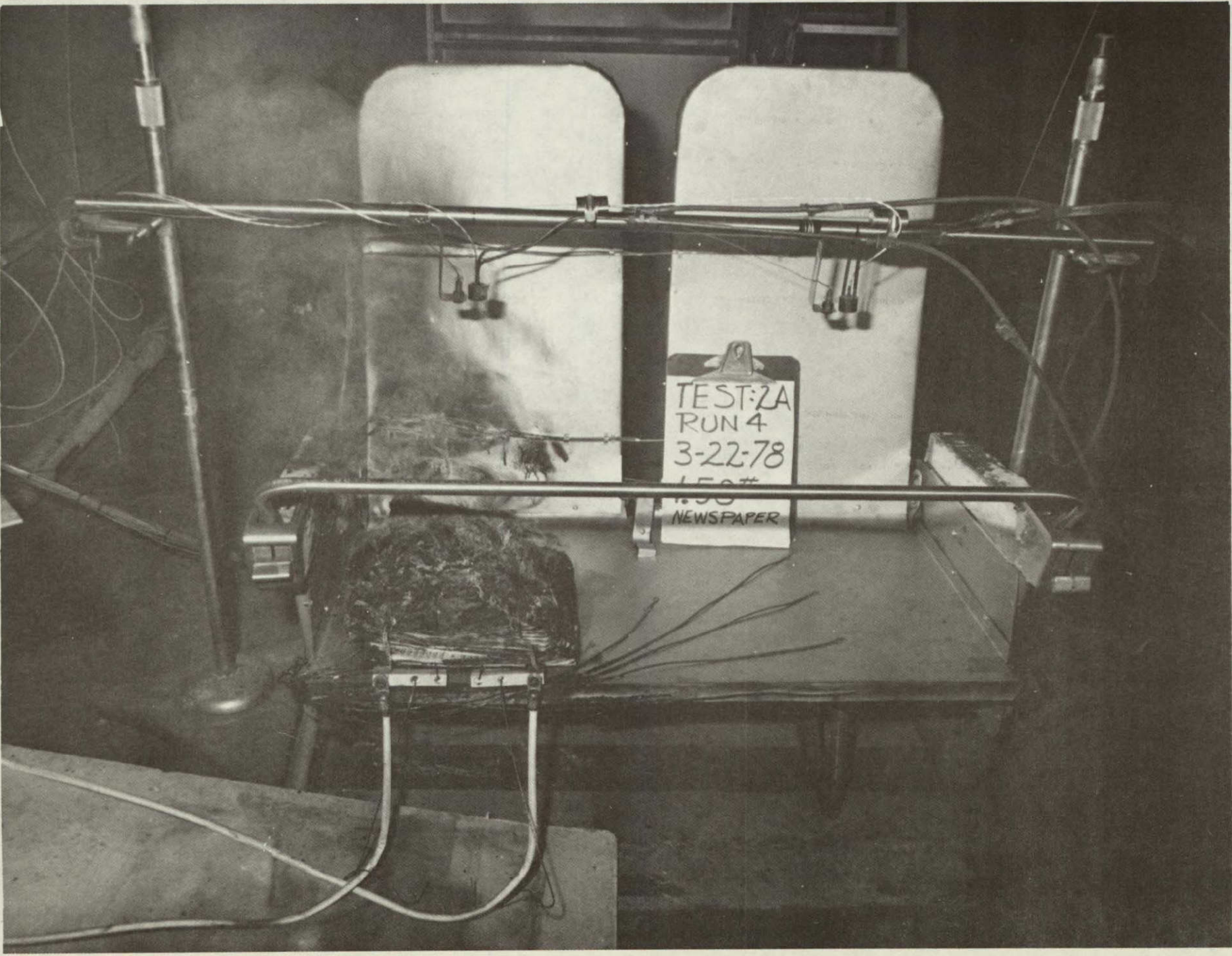


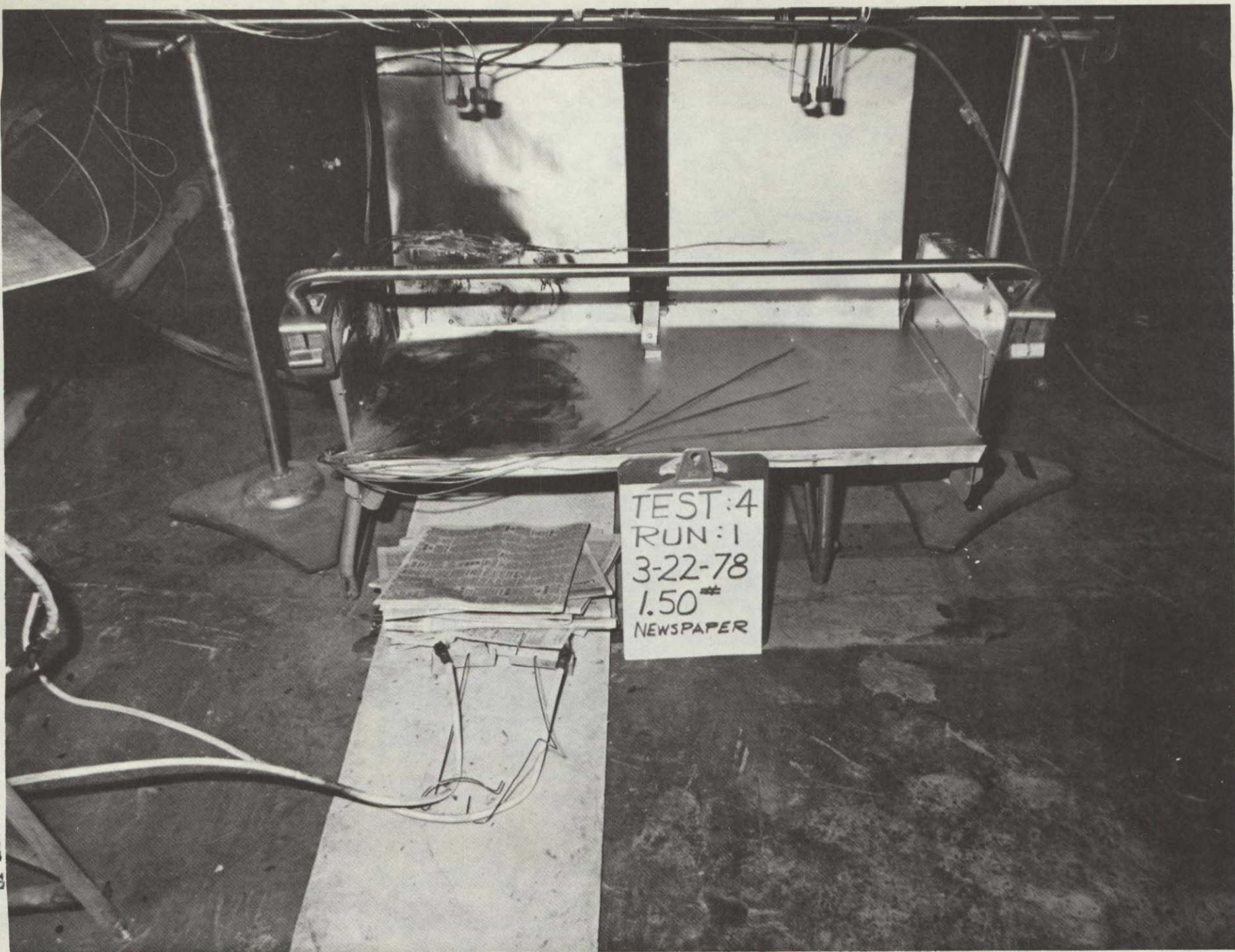
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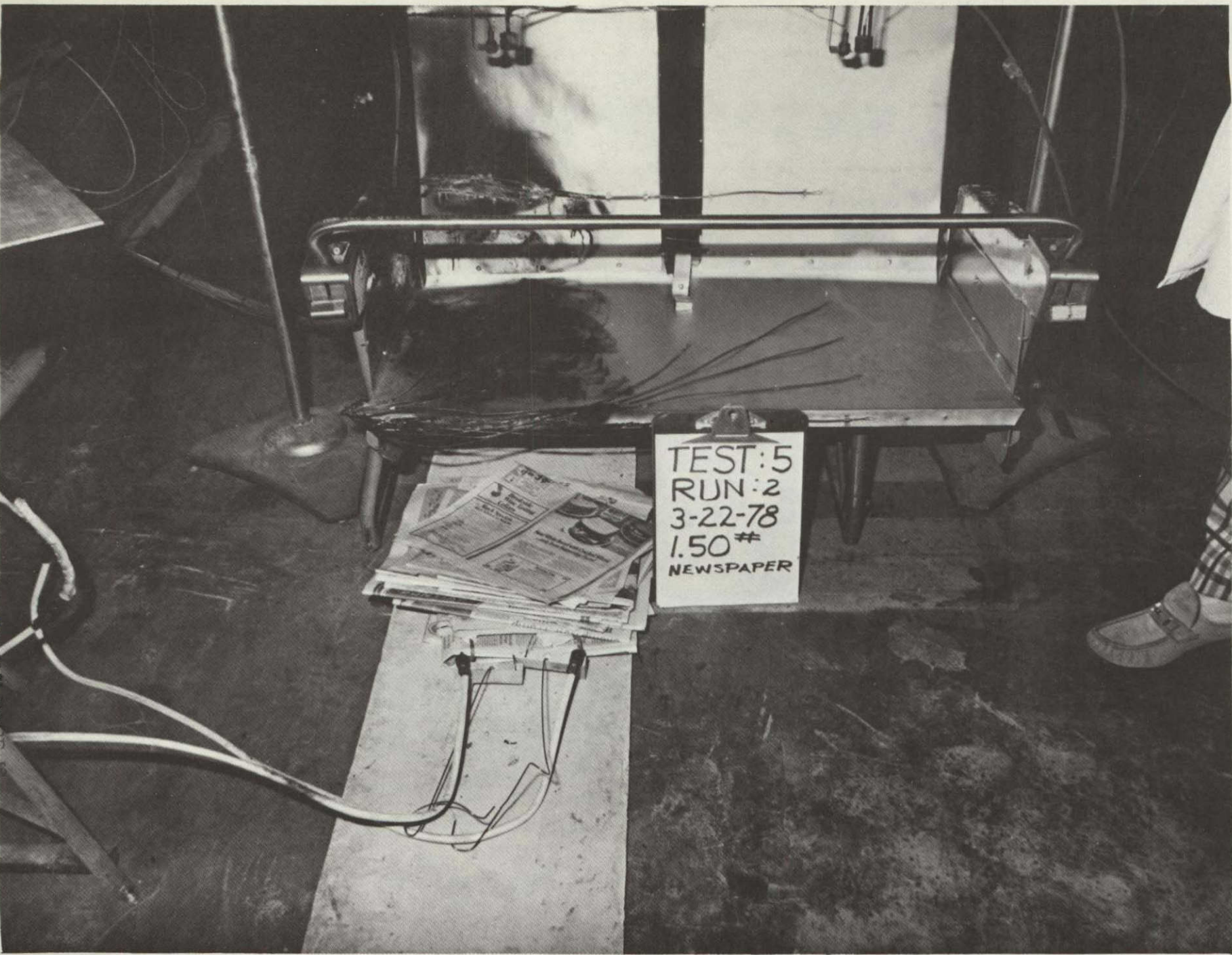
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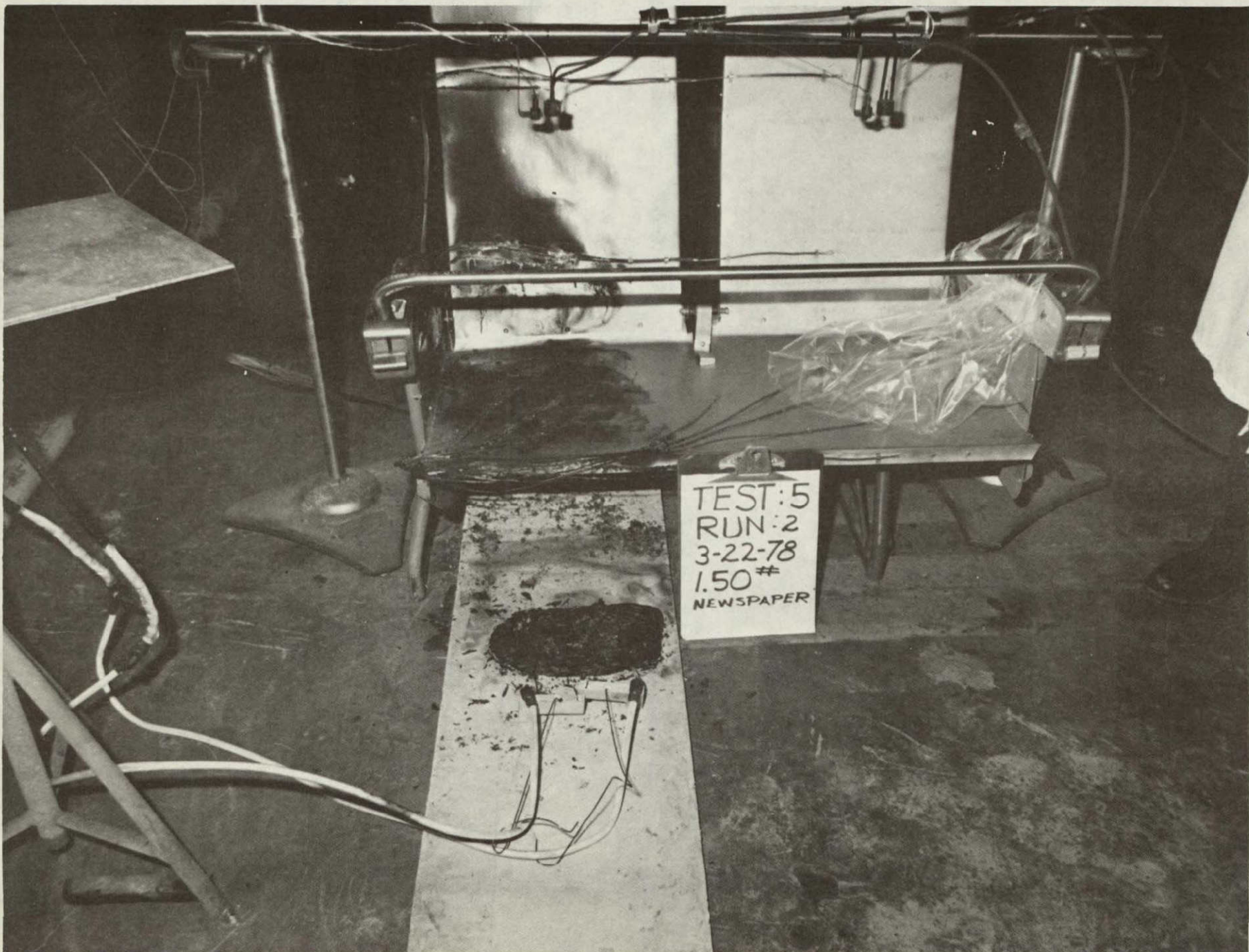
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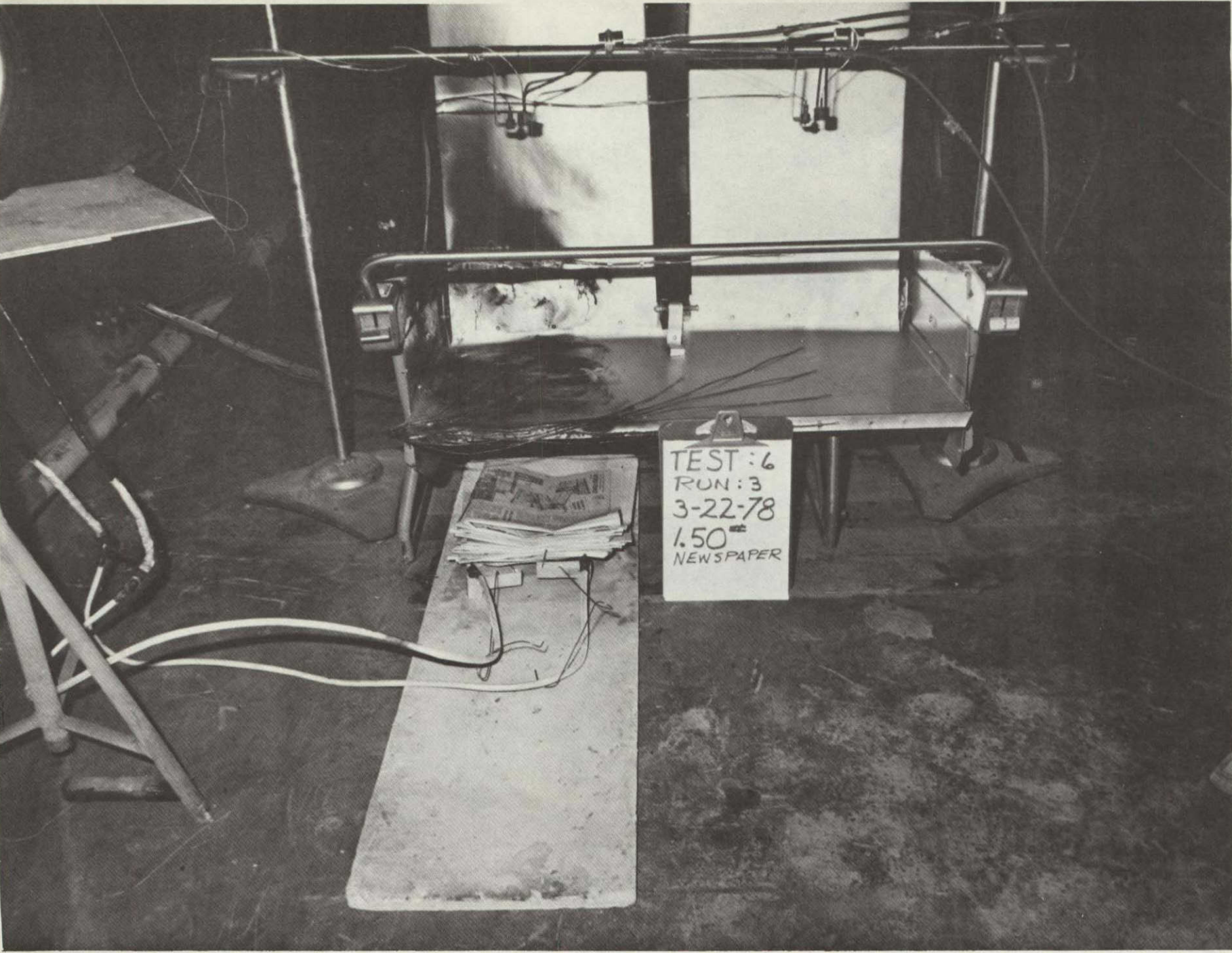
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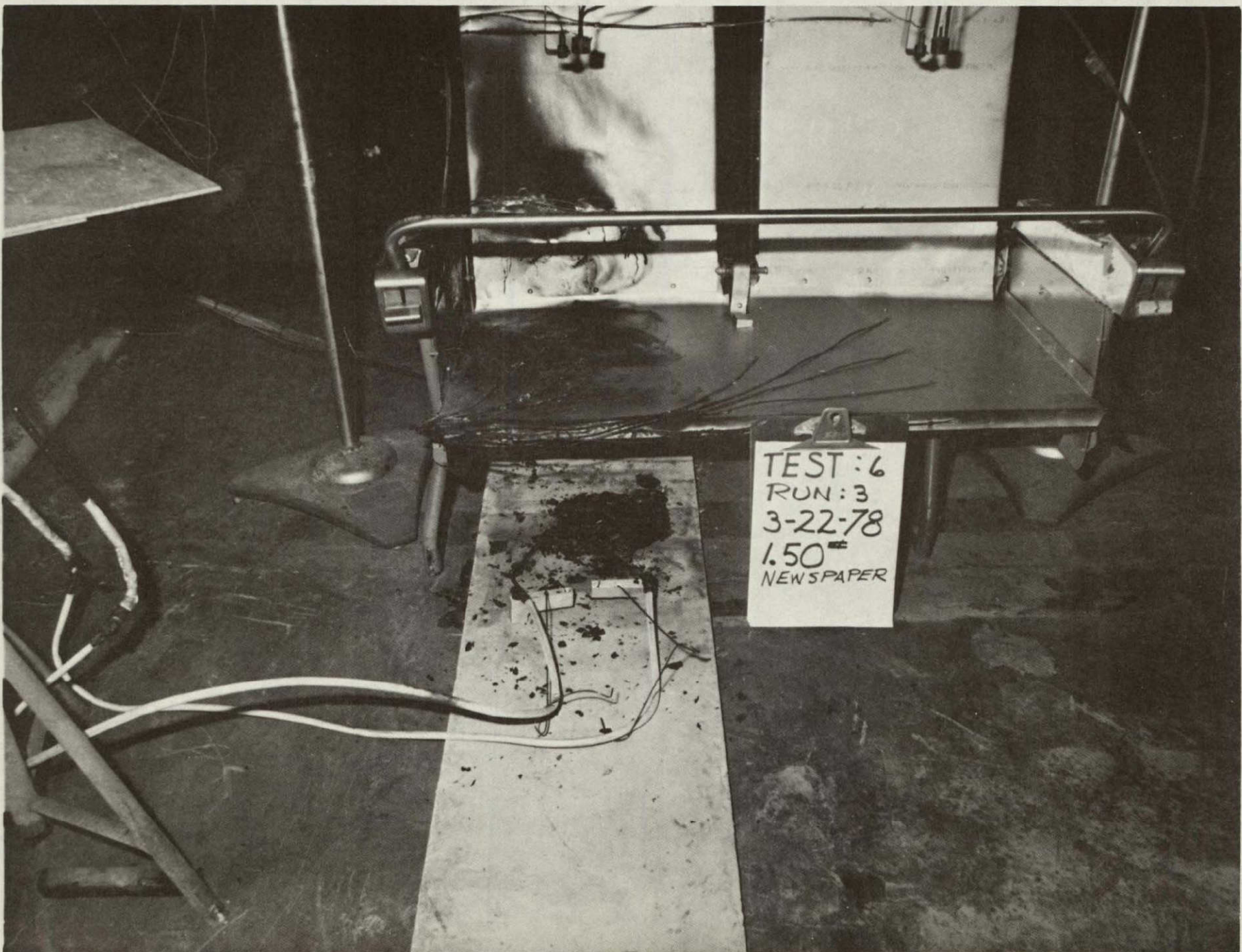
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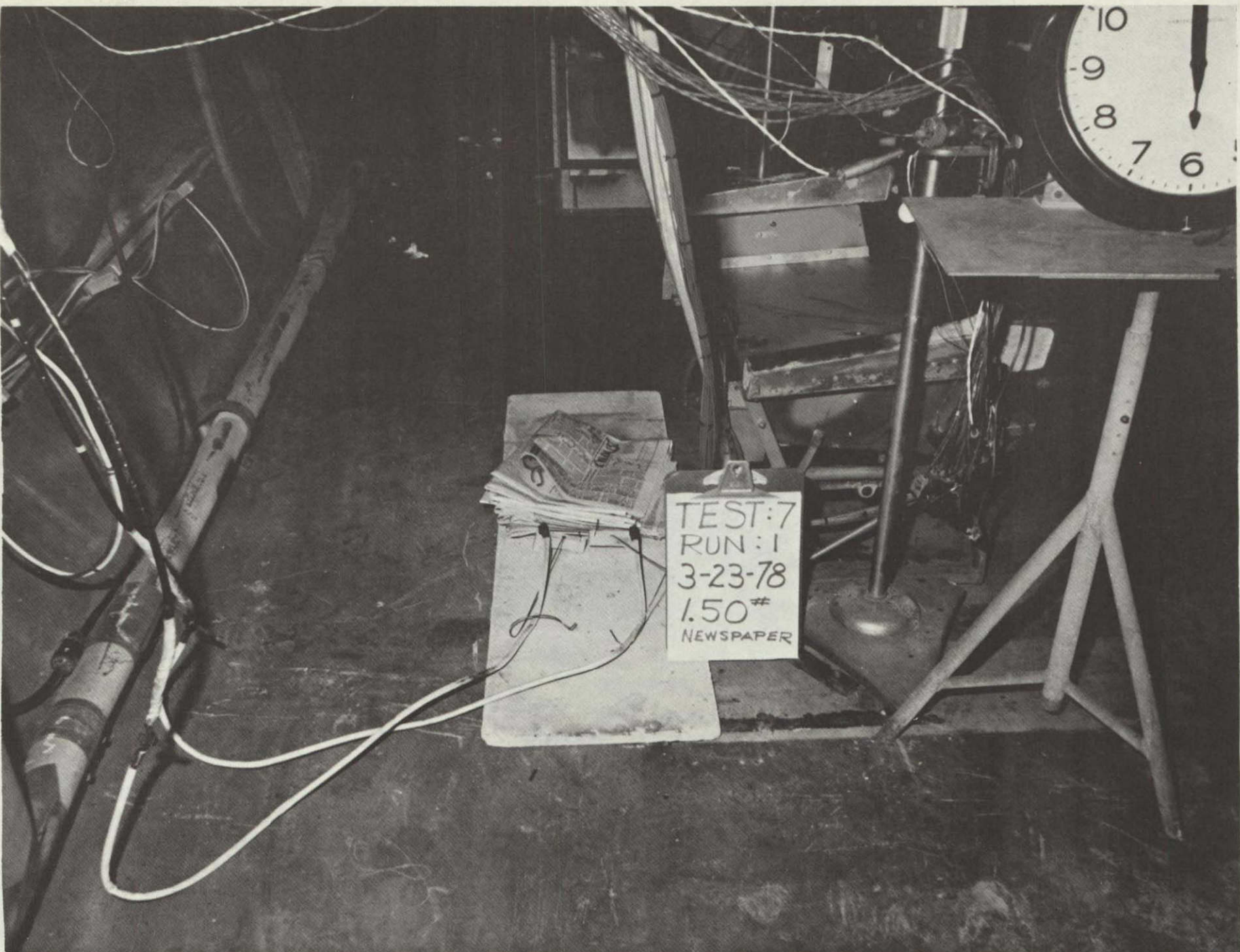




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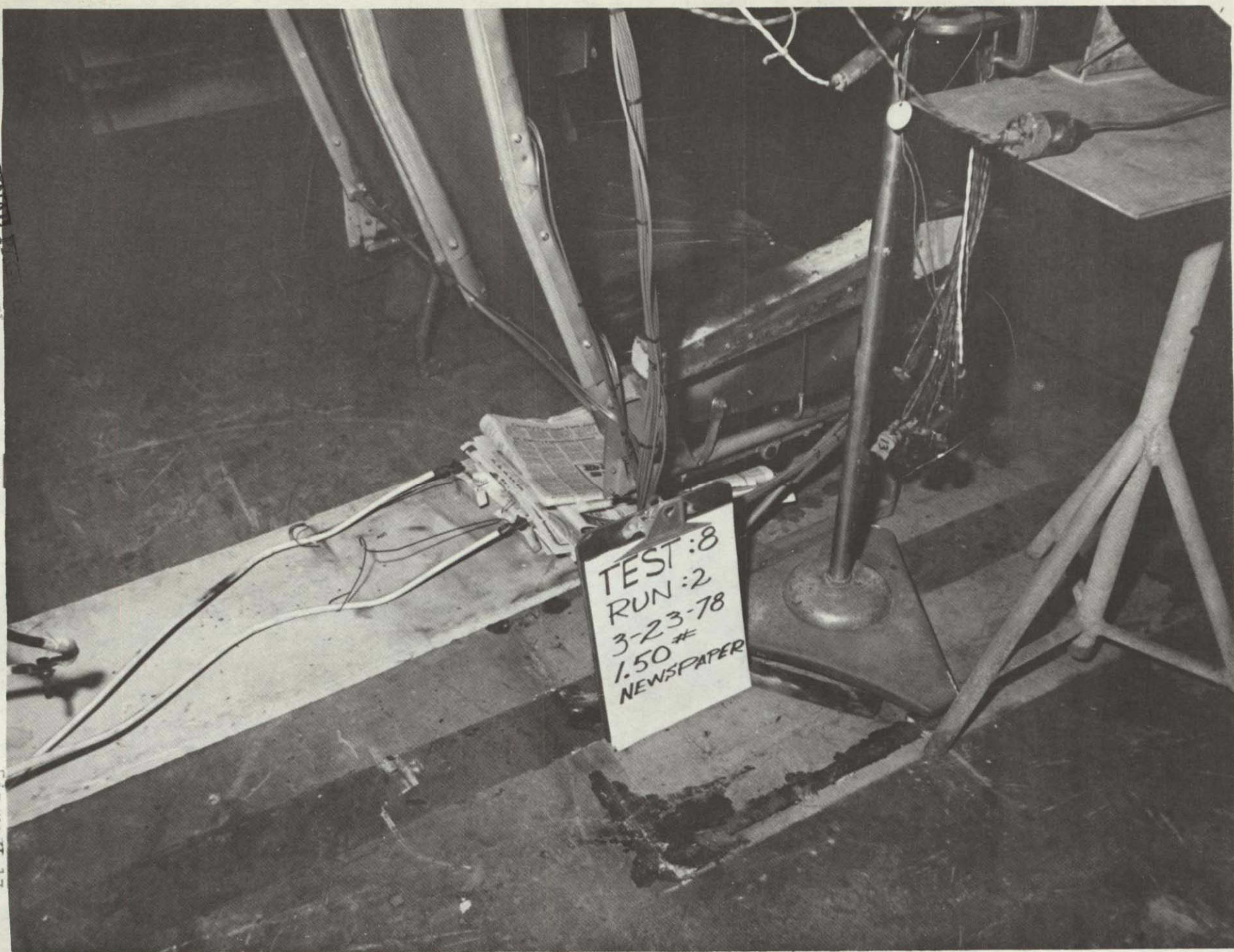
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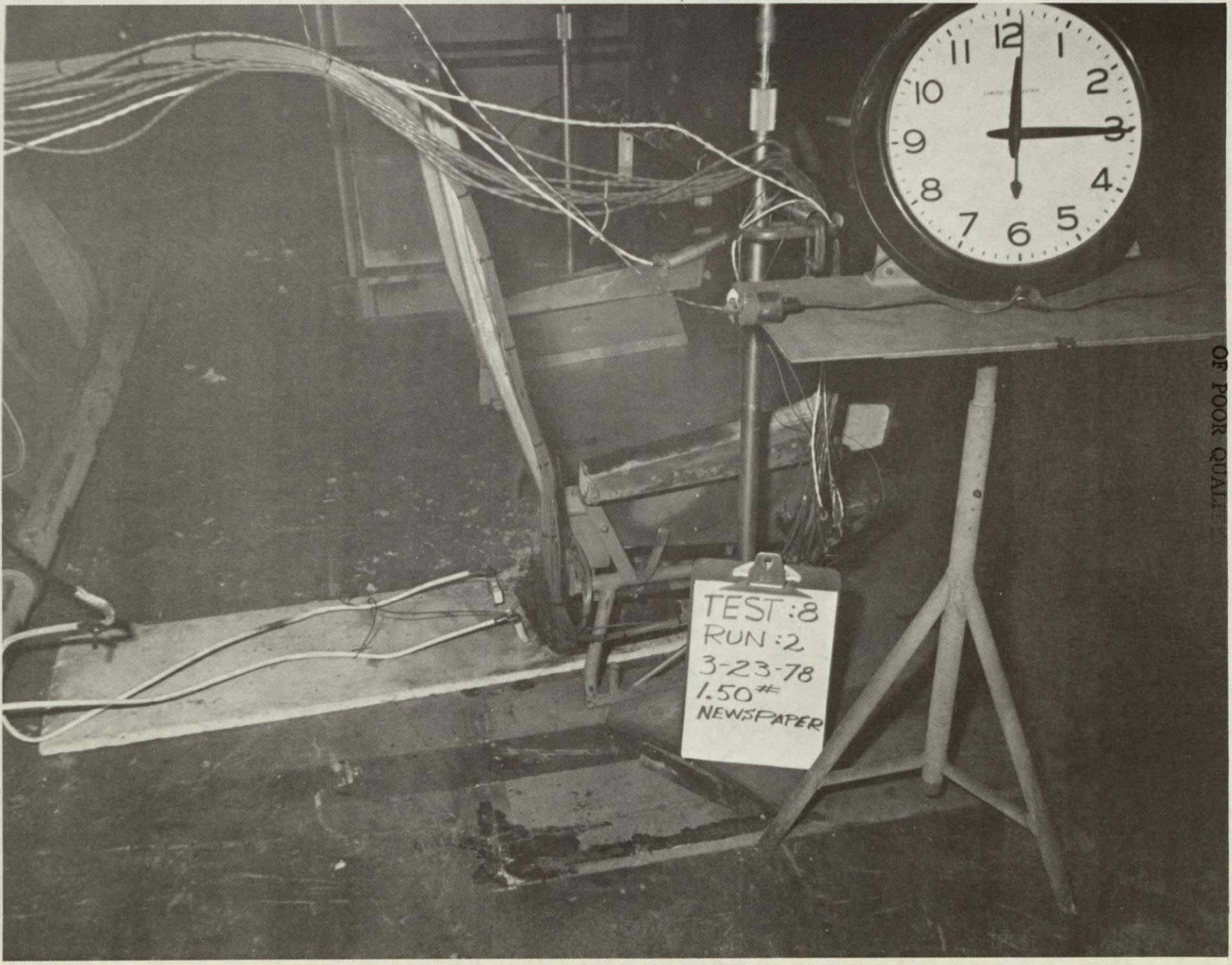
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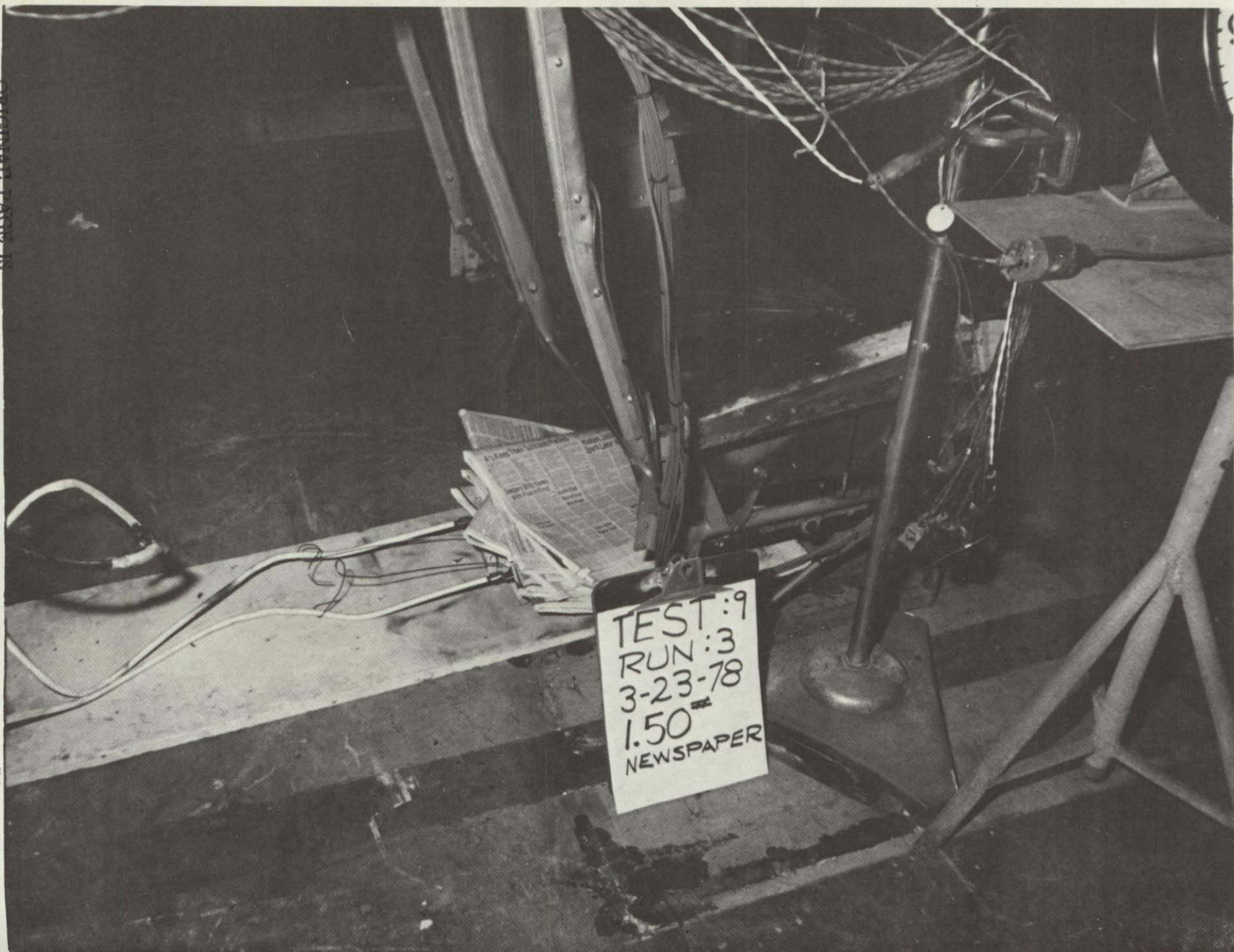
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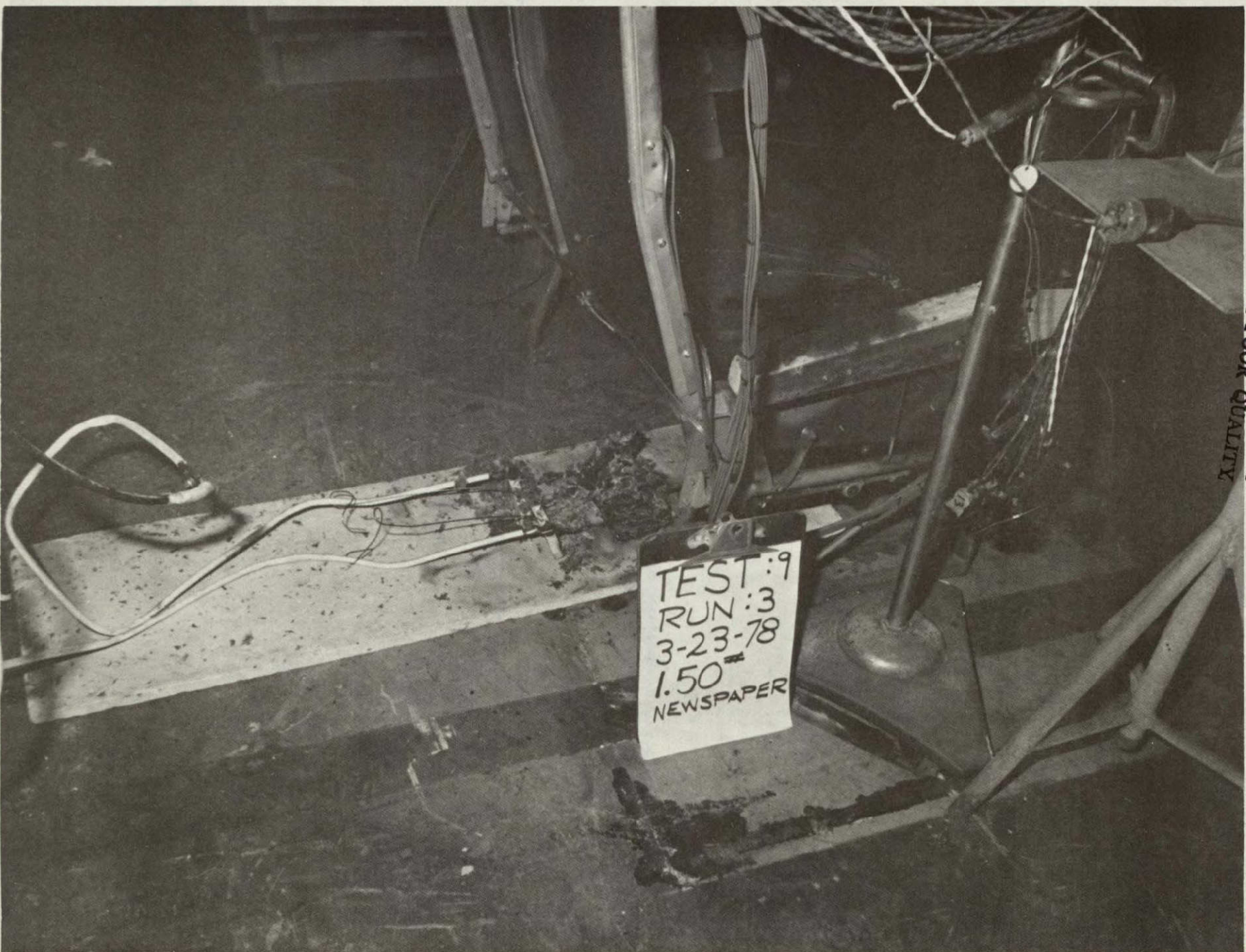
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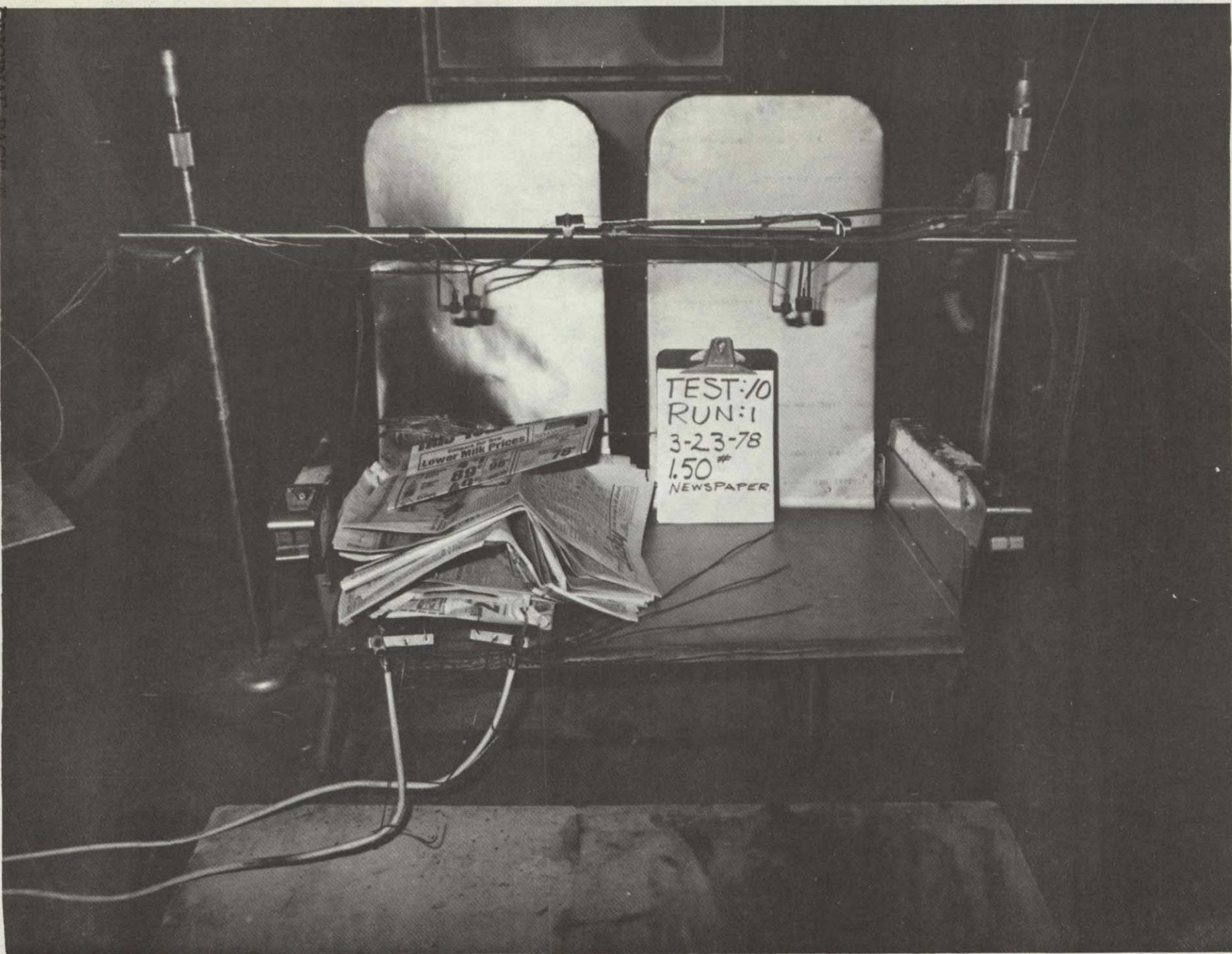
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Figure II-19



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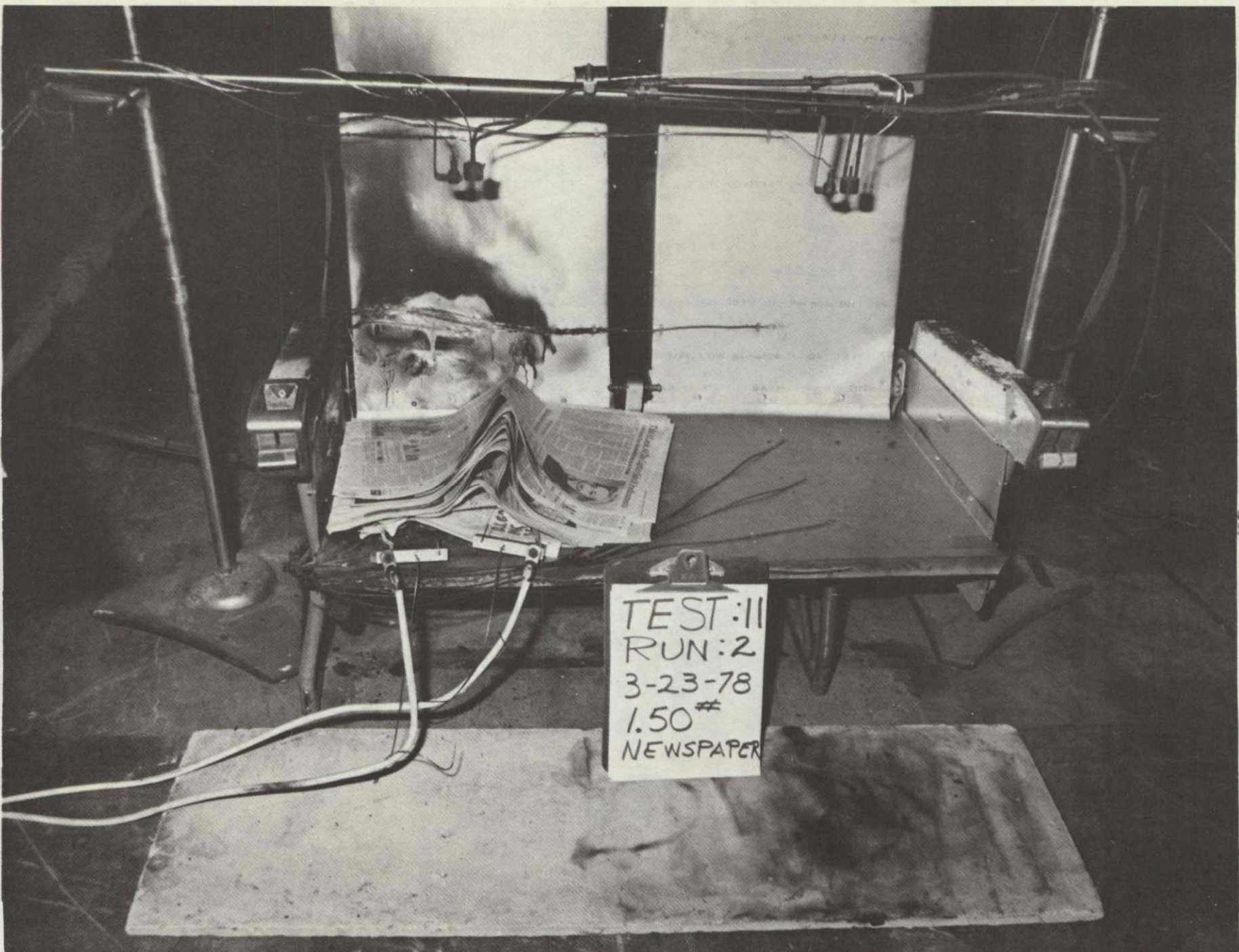




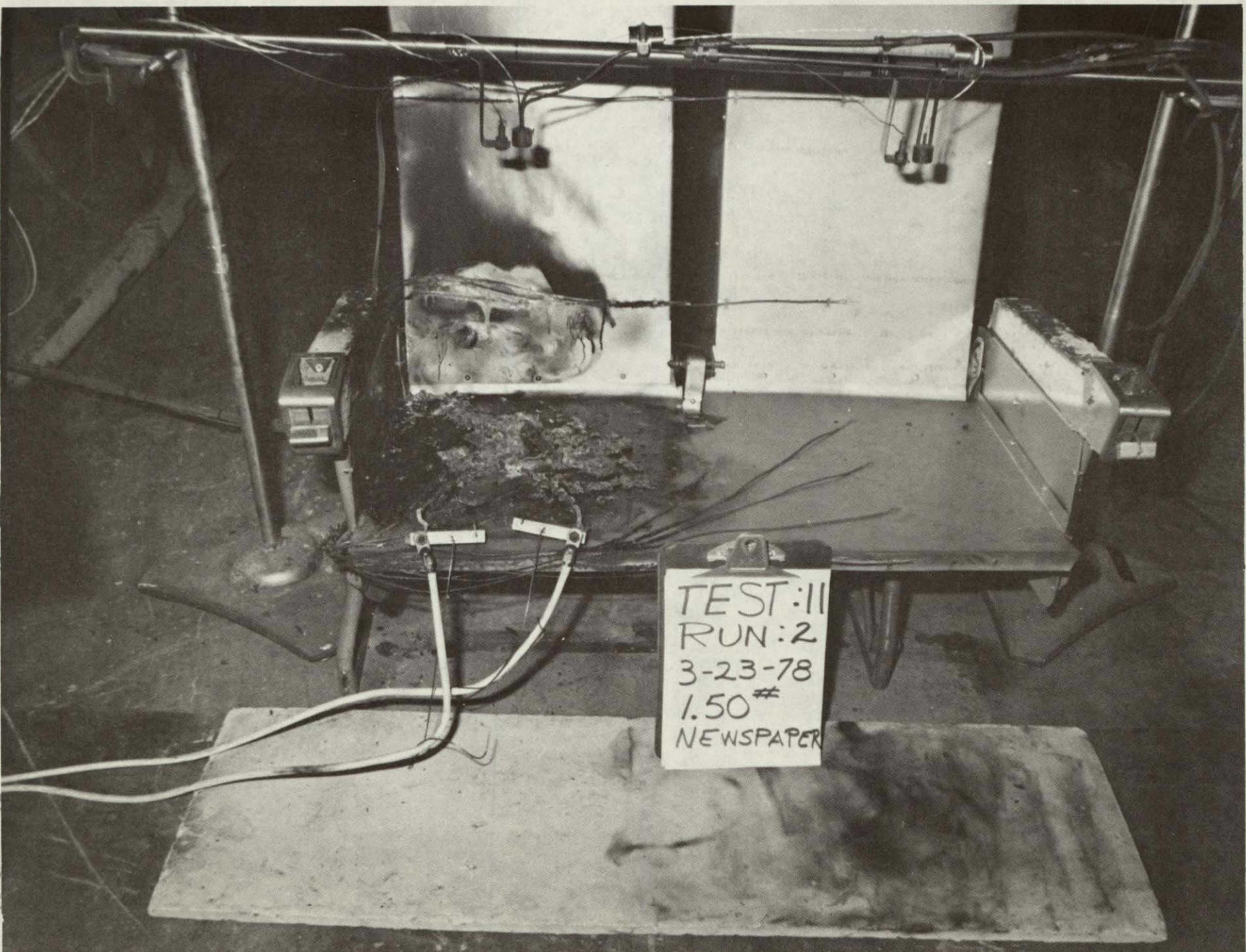
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TEST:10
RUN:1
3-23-78
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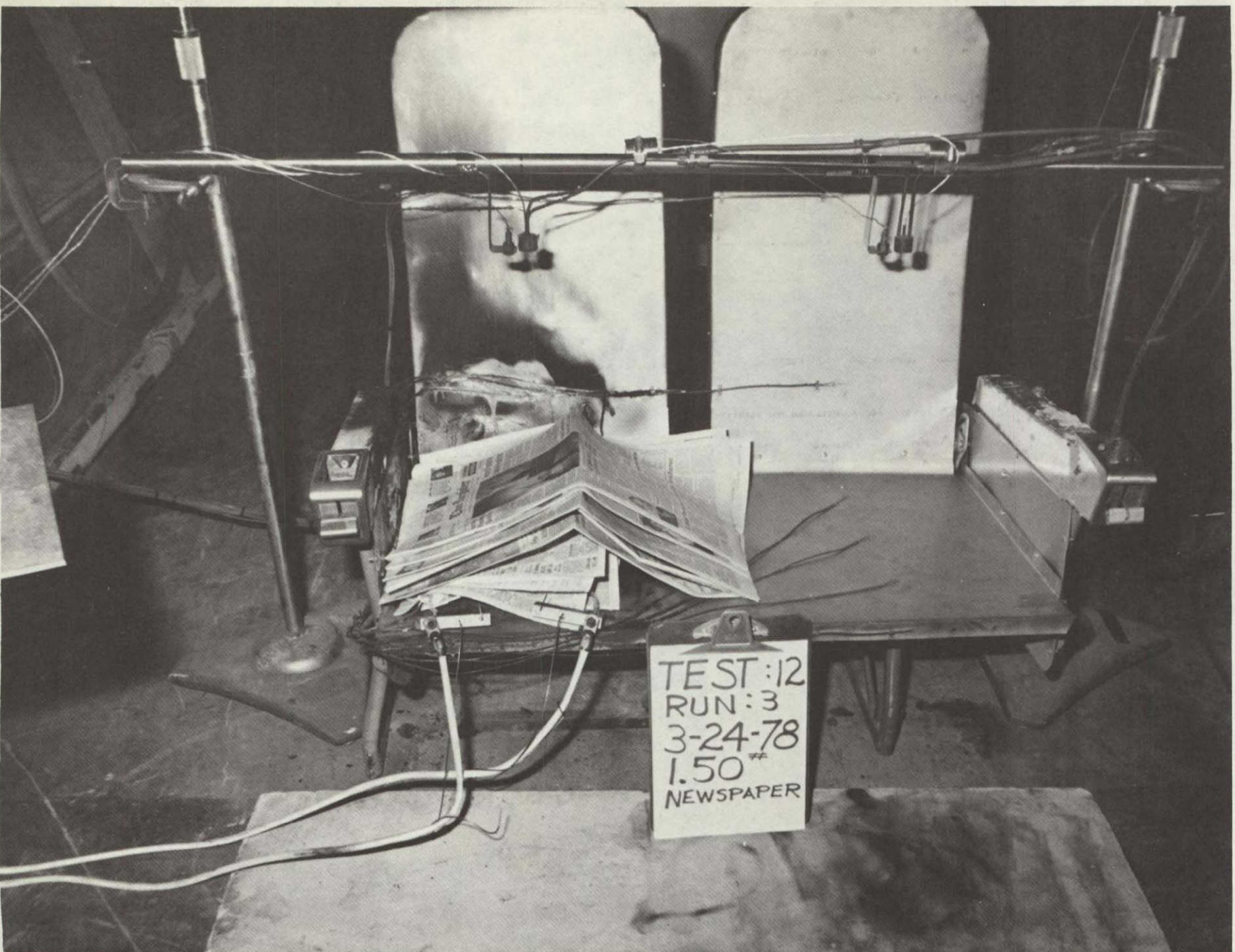
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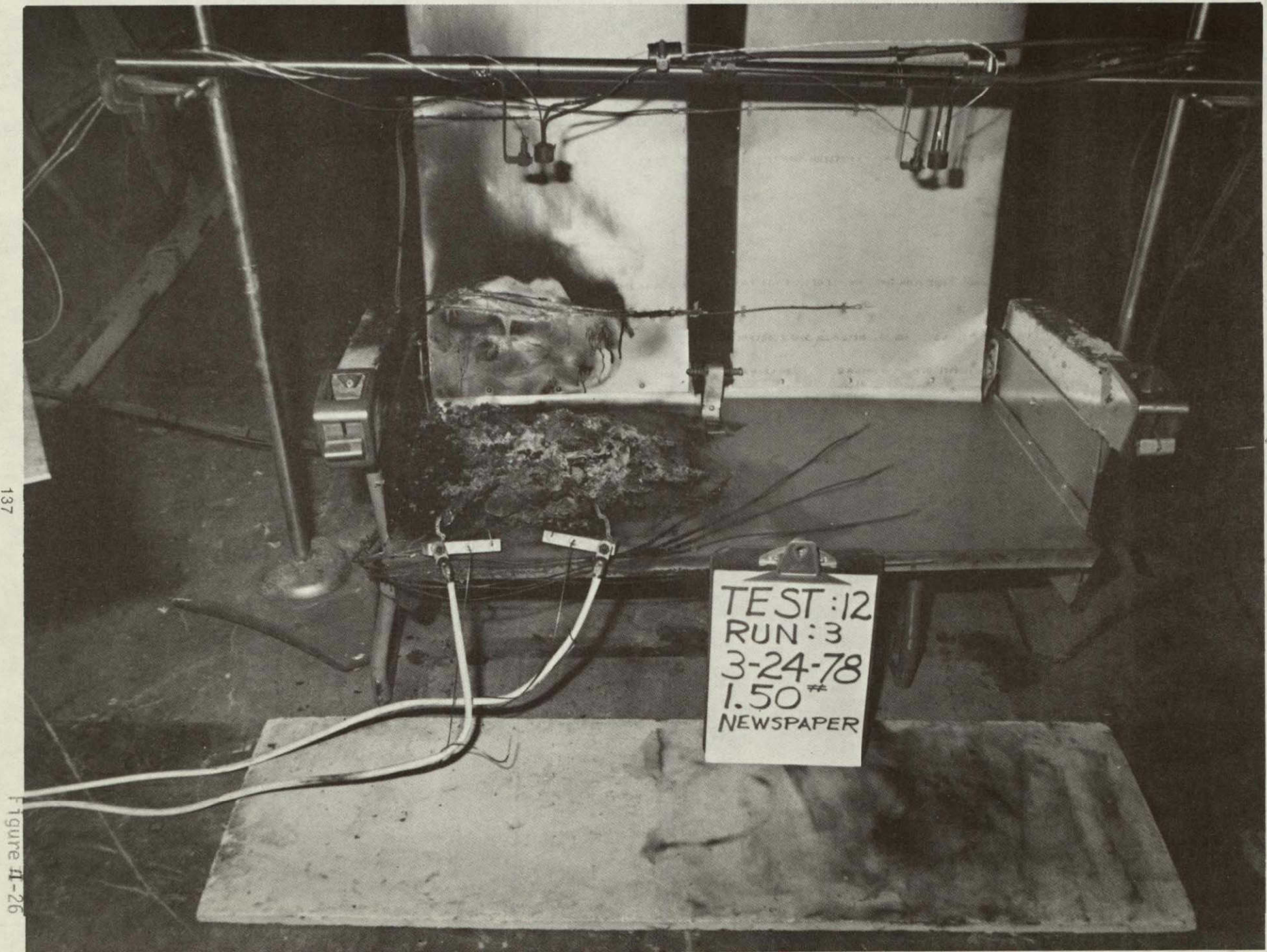


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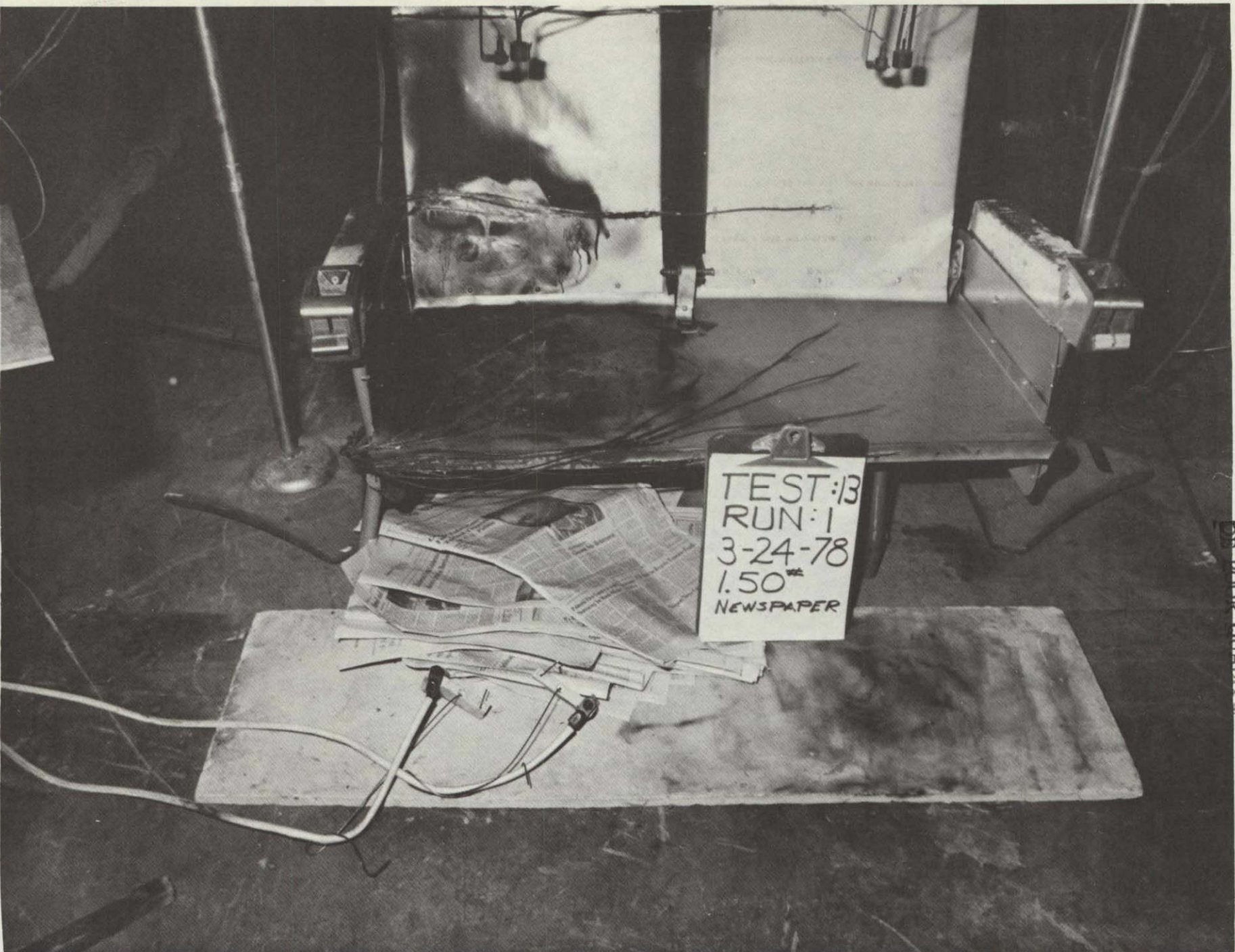


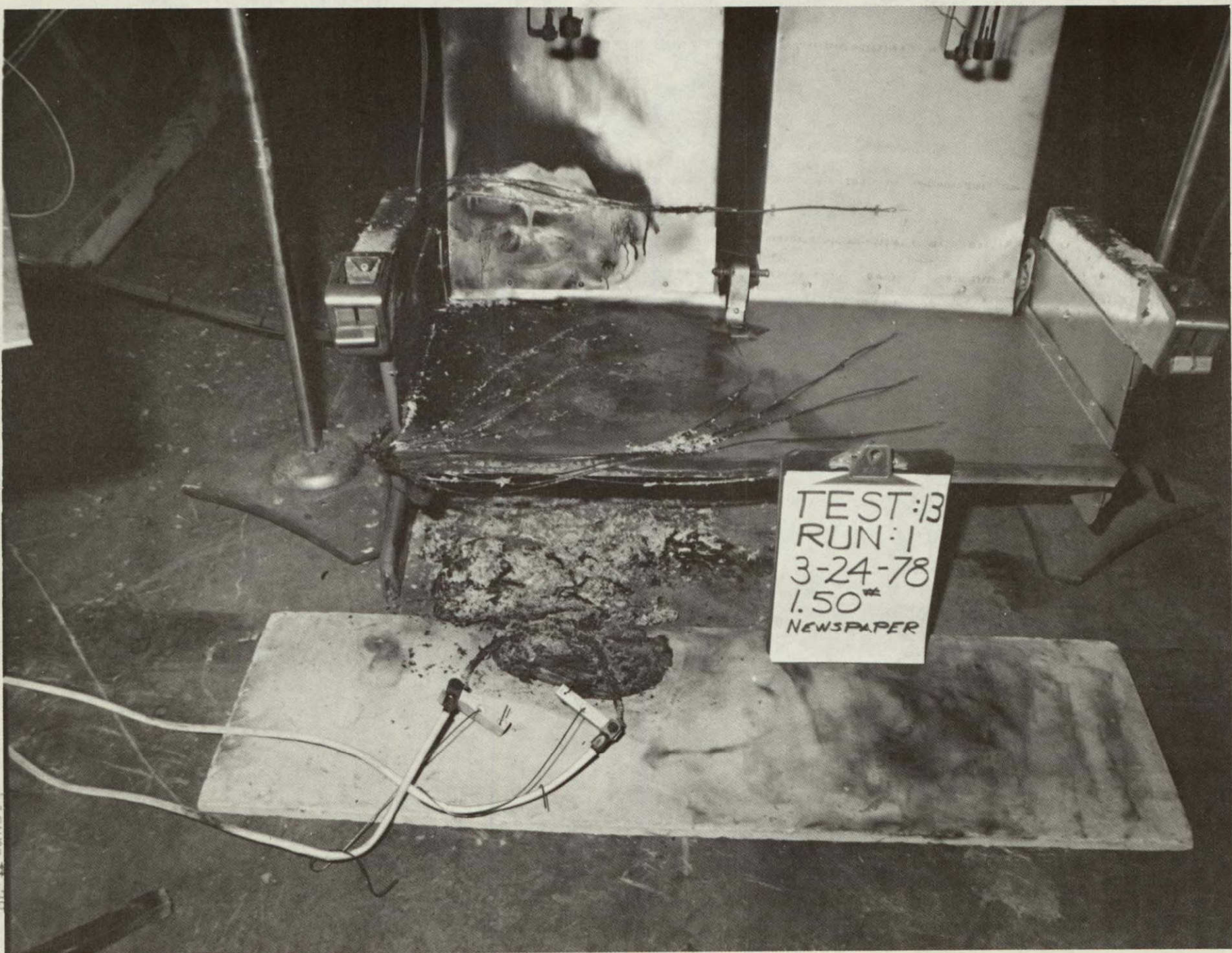
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3-24-78
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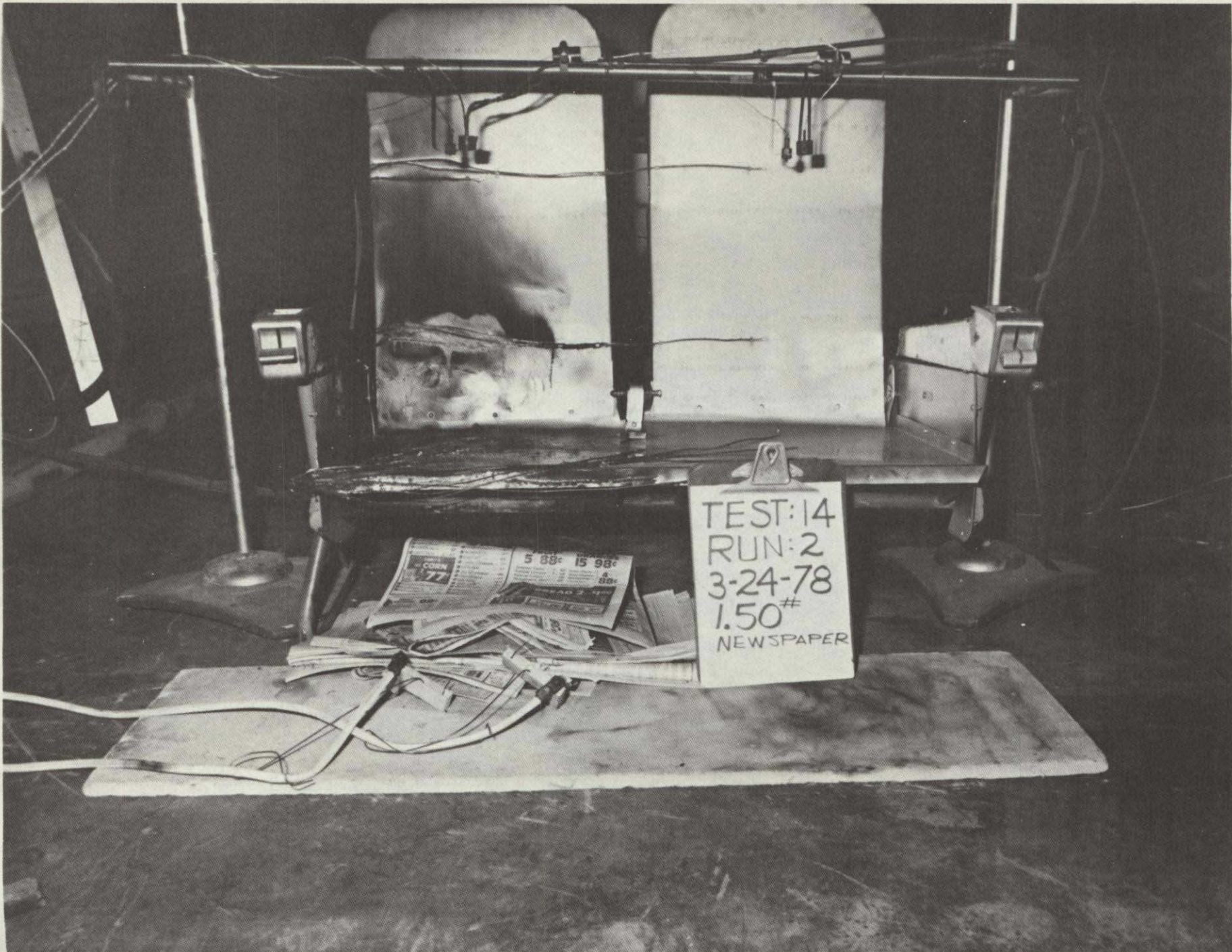


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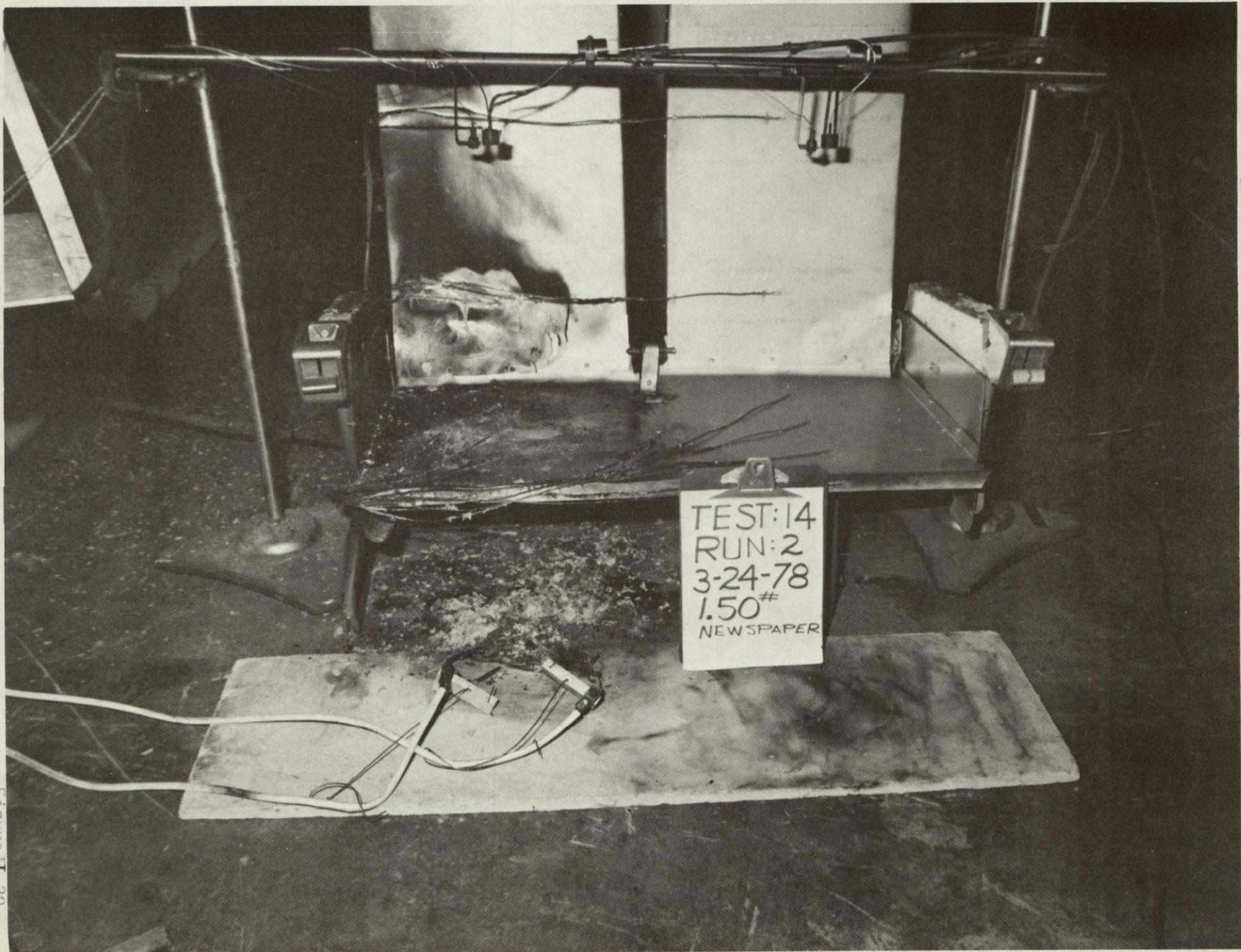




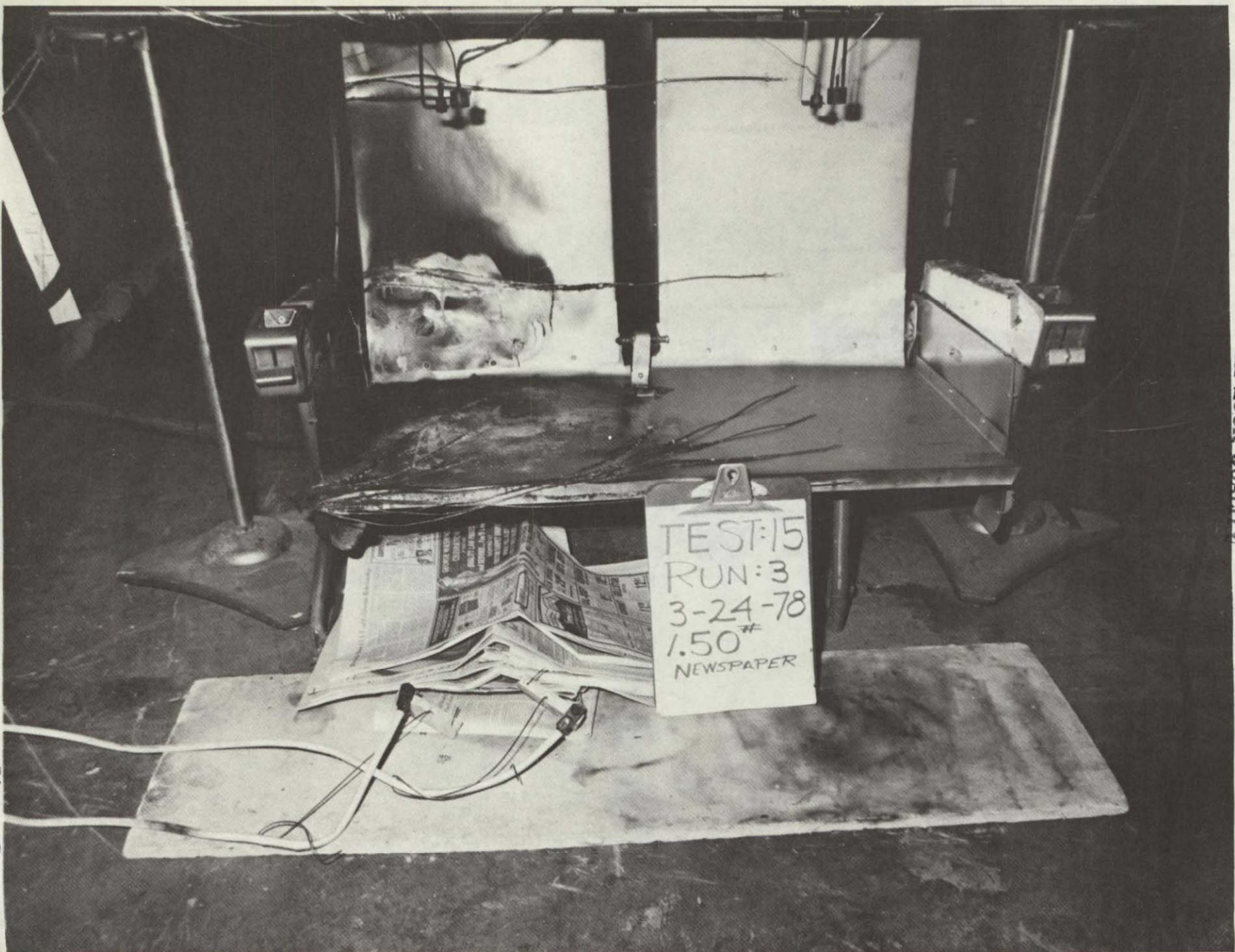
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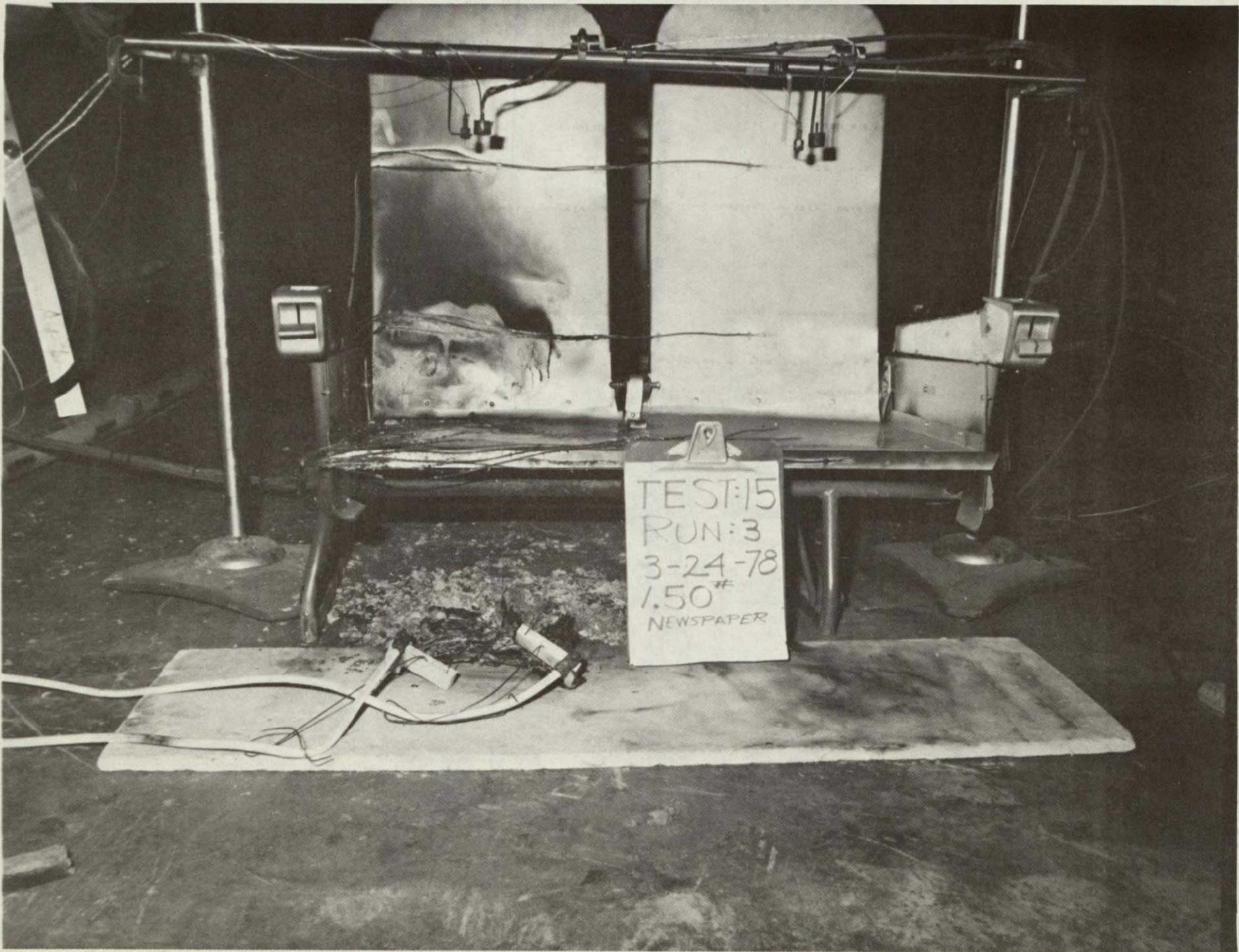


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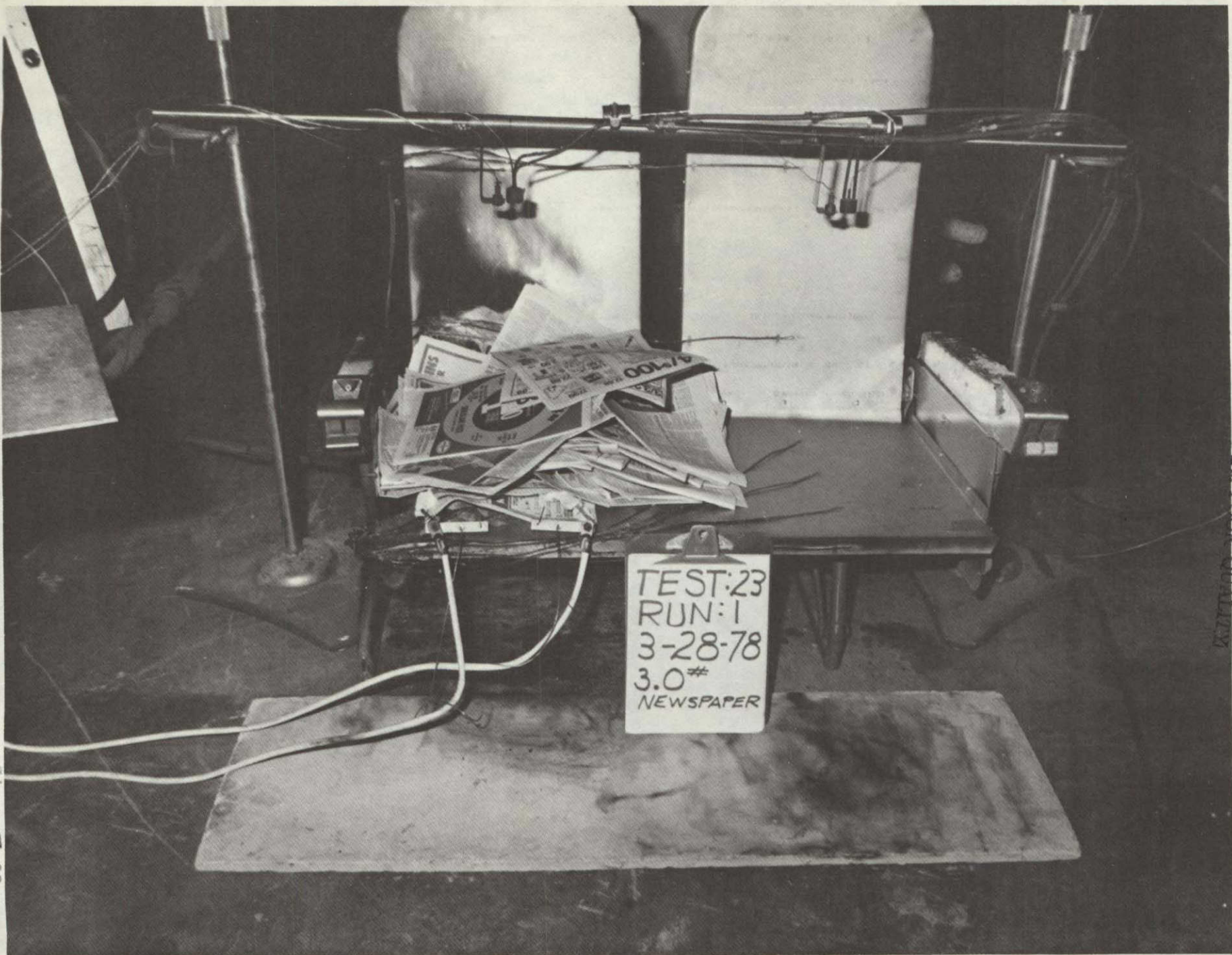


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3-24-78
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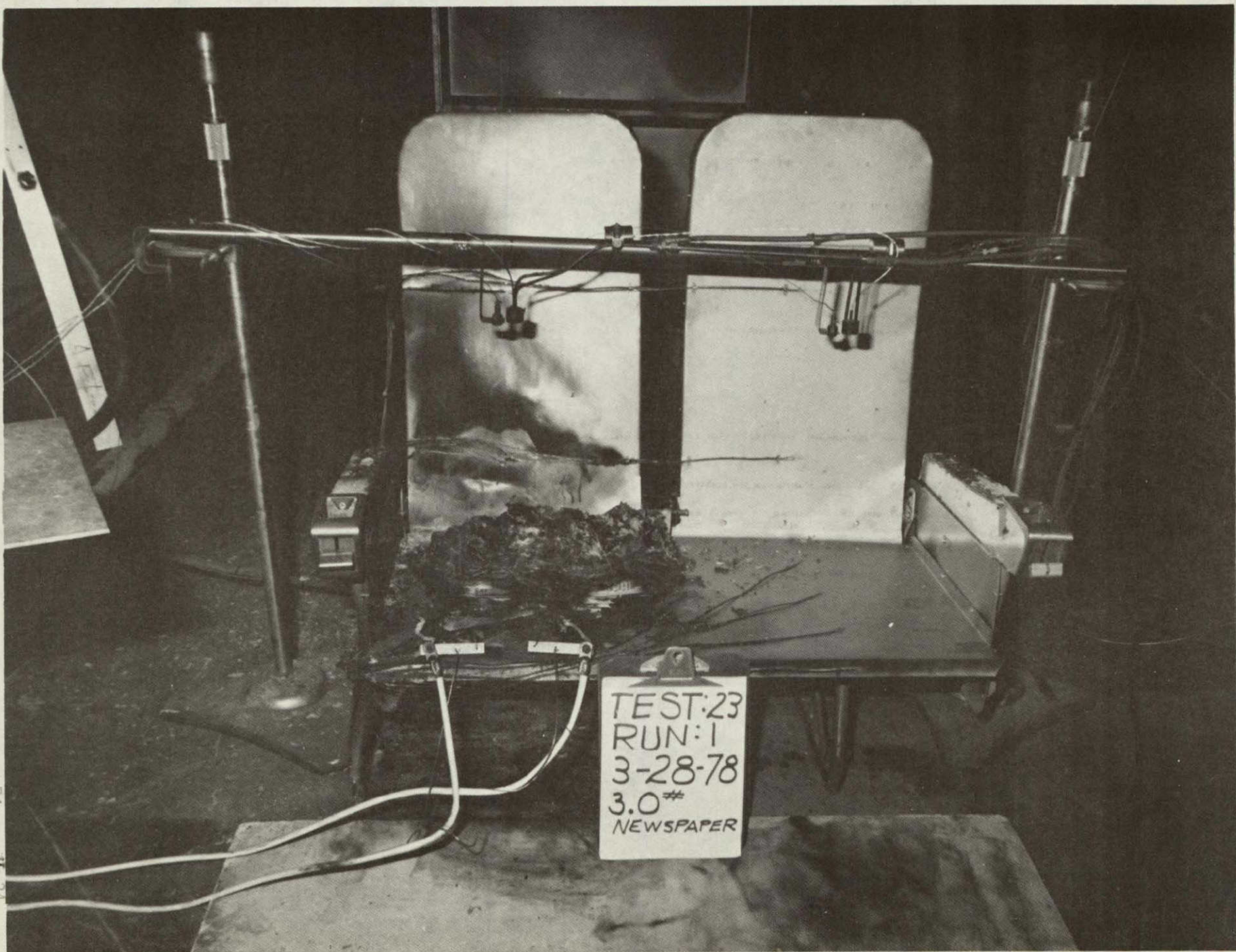
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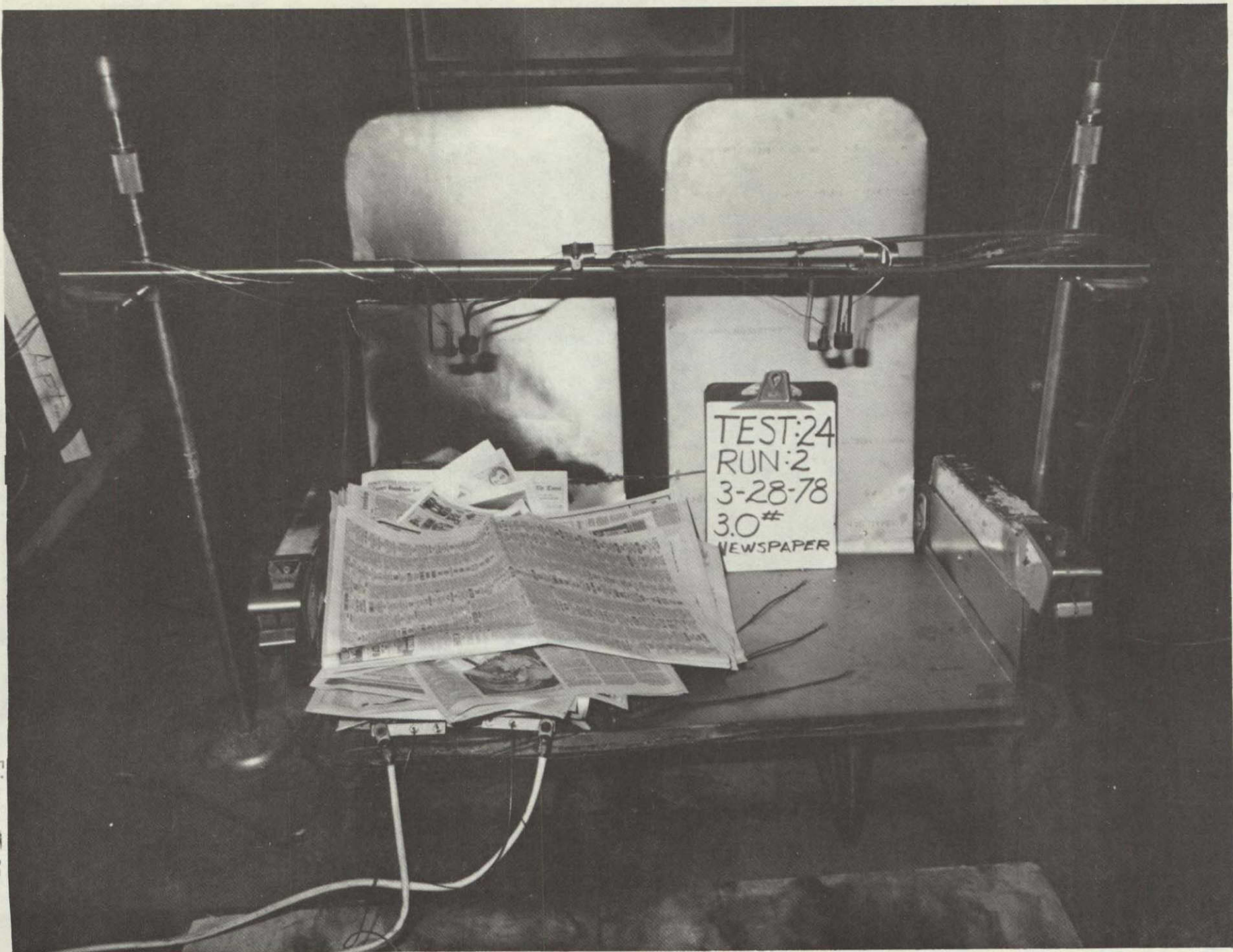
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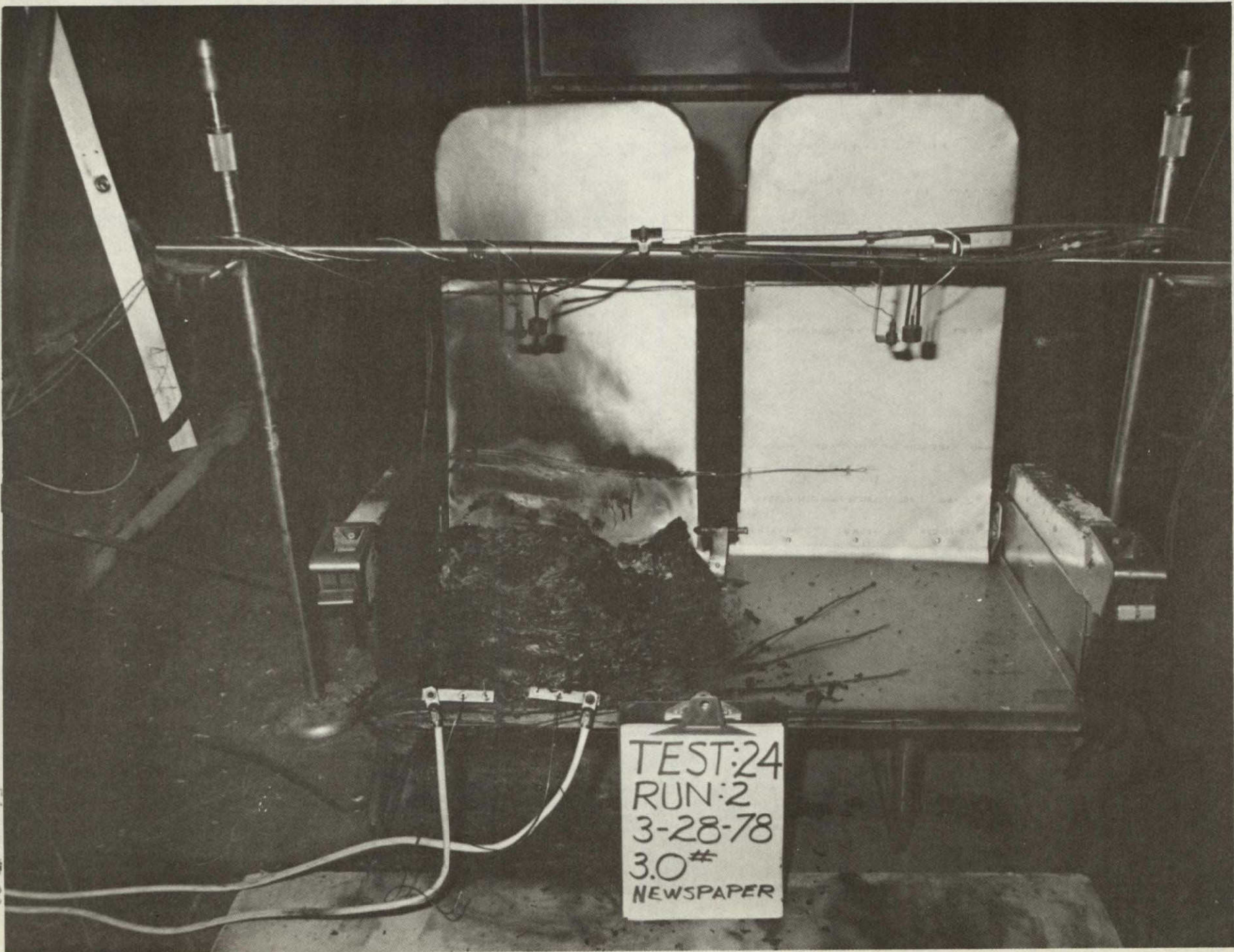
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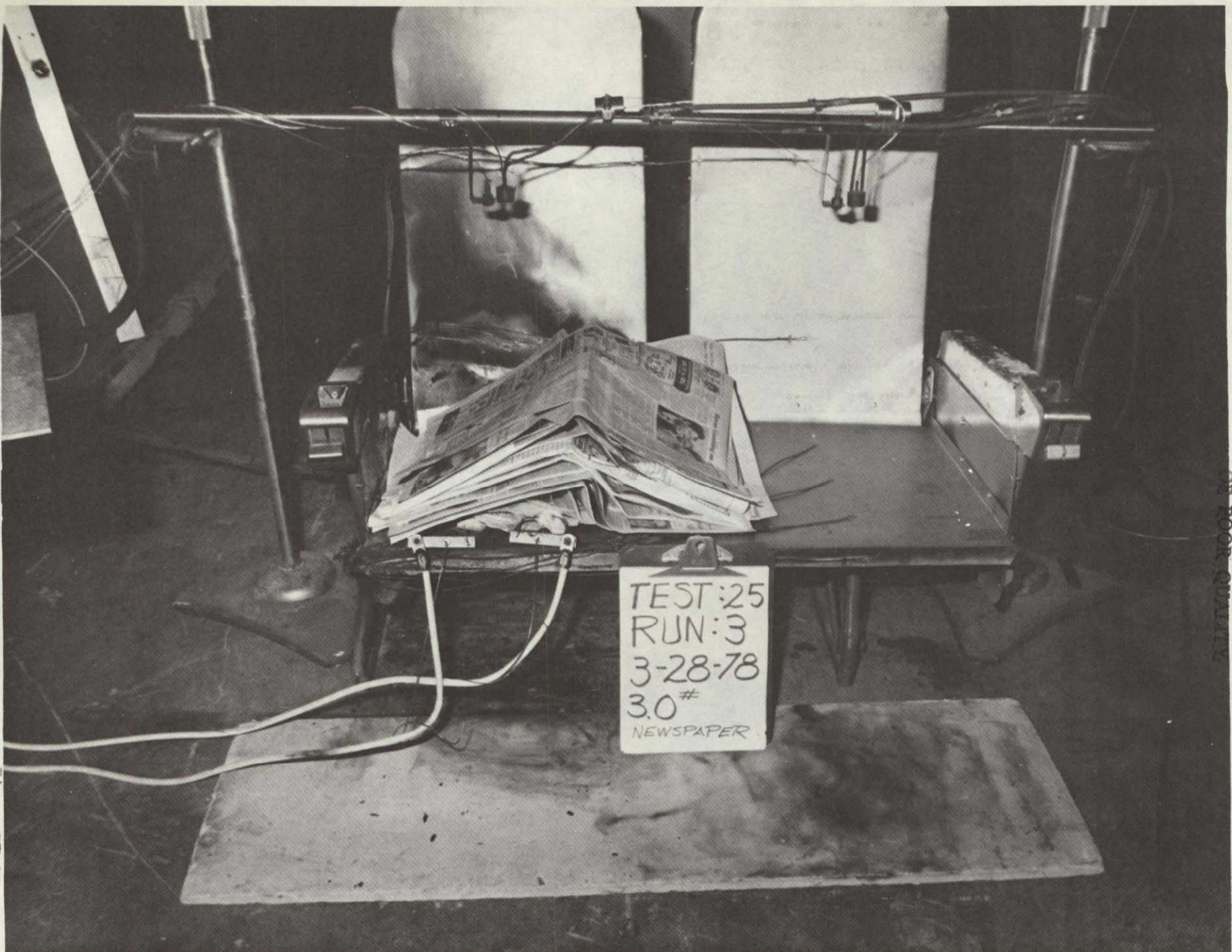
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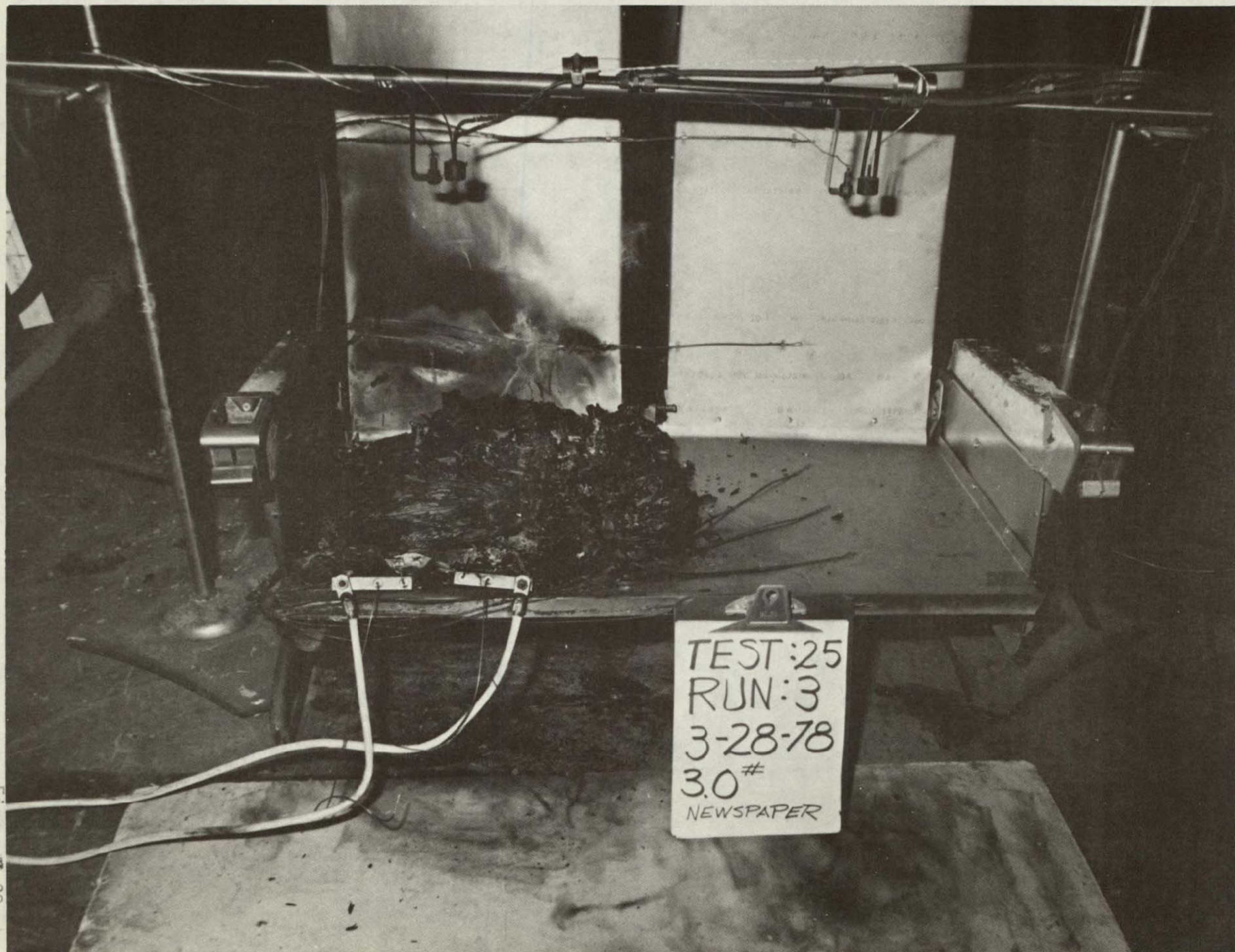
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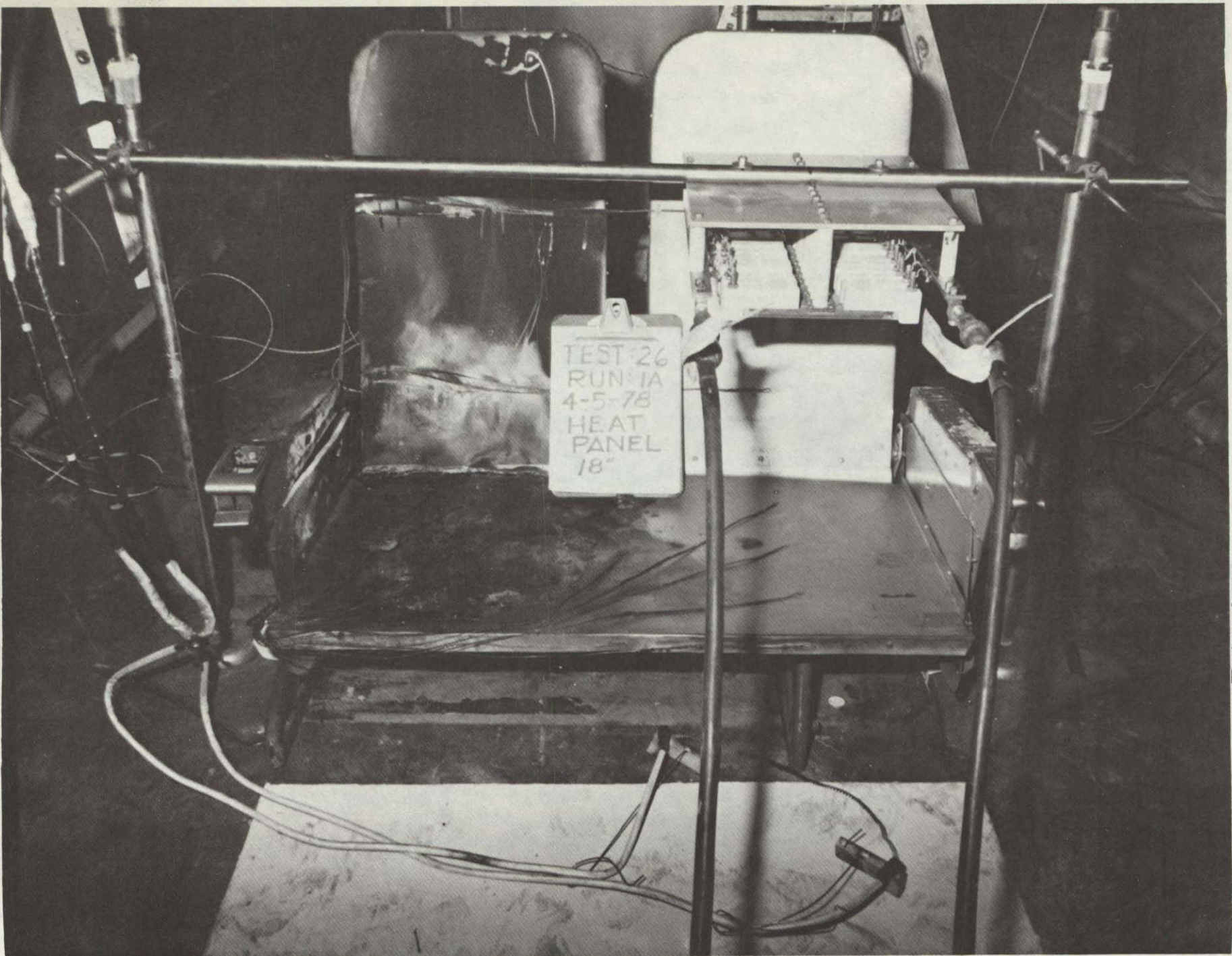
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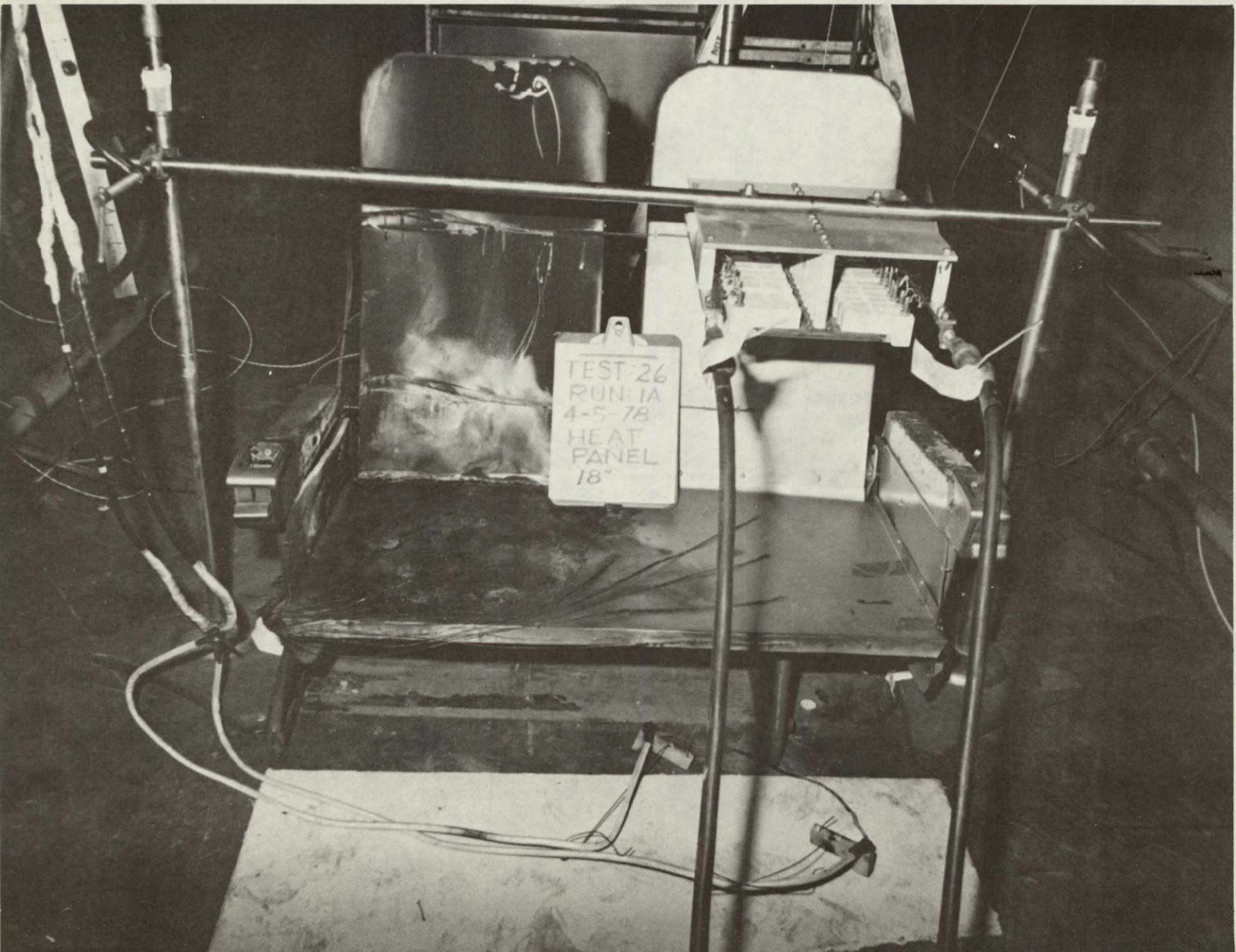
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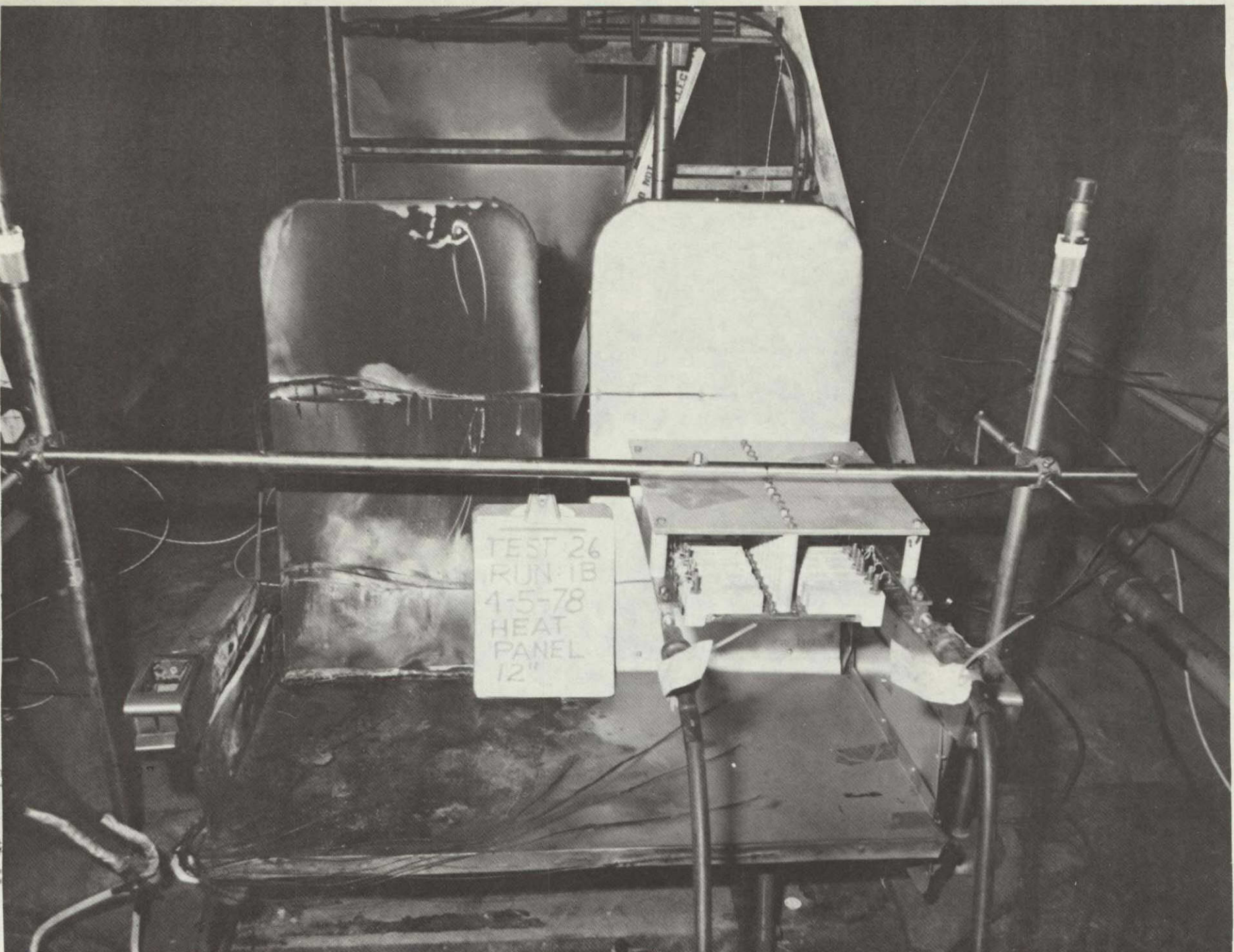
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RUN:3
3-28-78
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NEWSPAPER



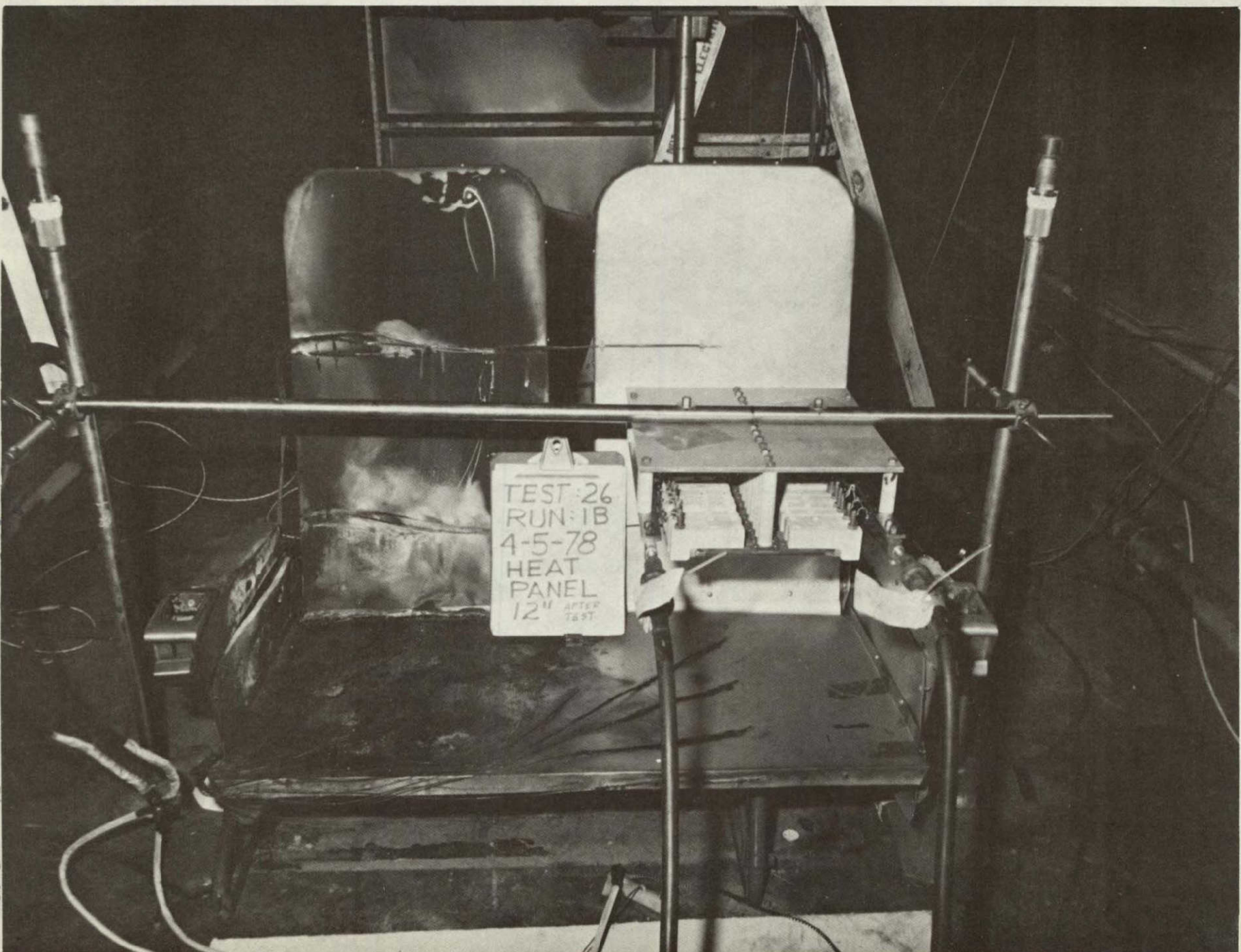
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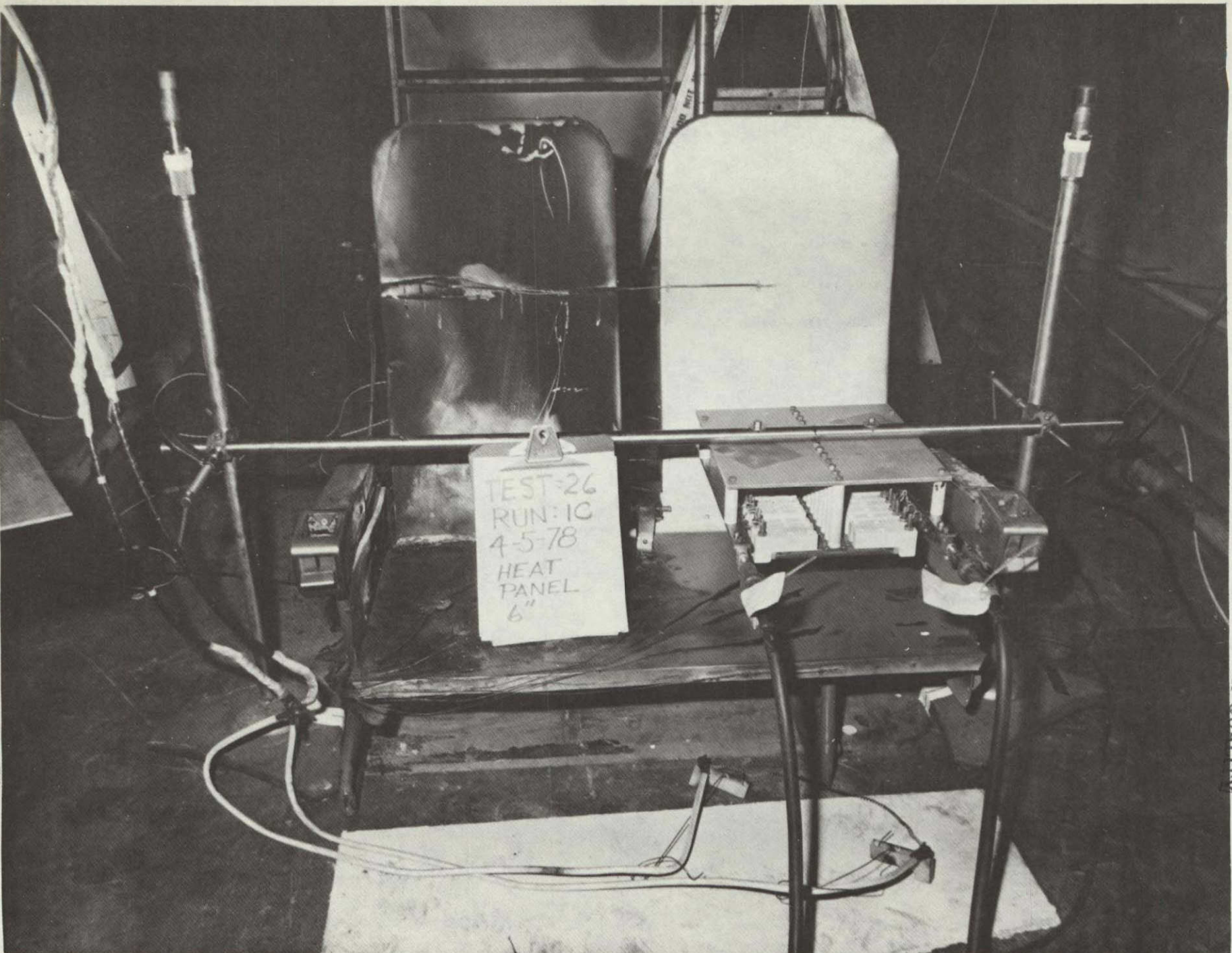
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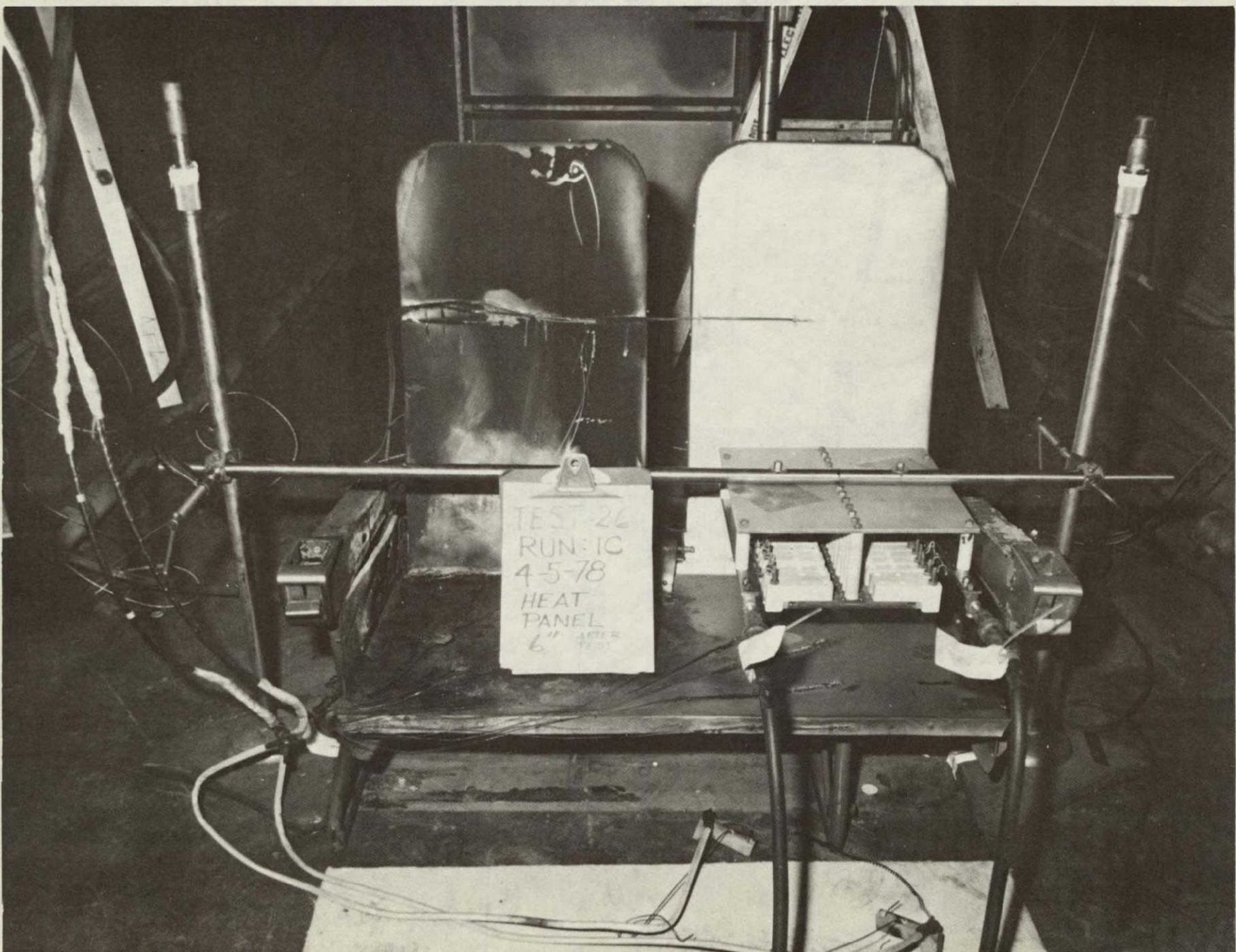
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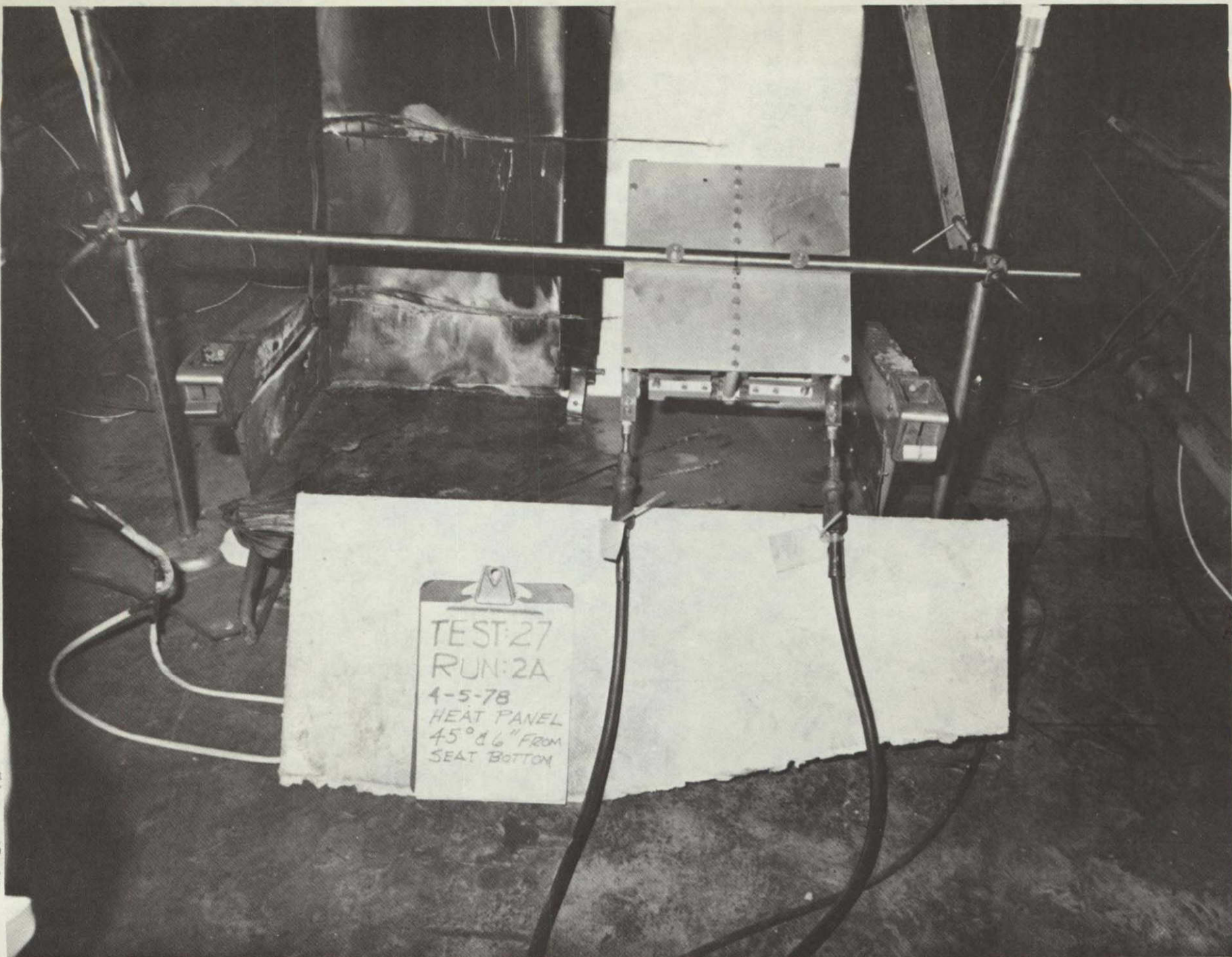
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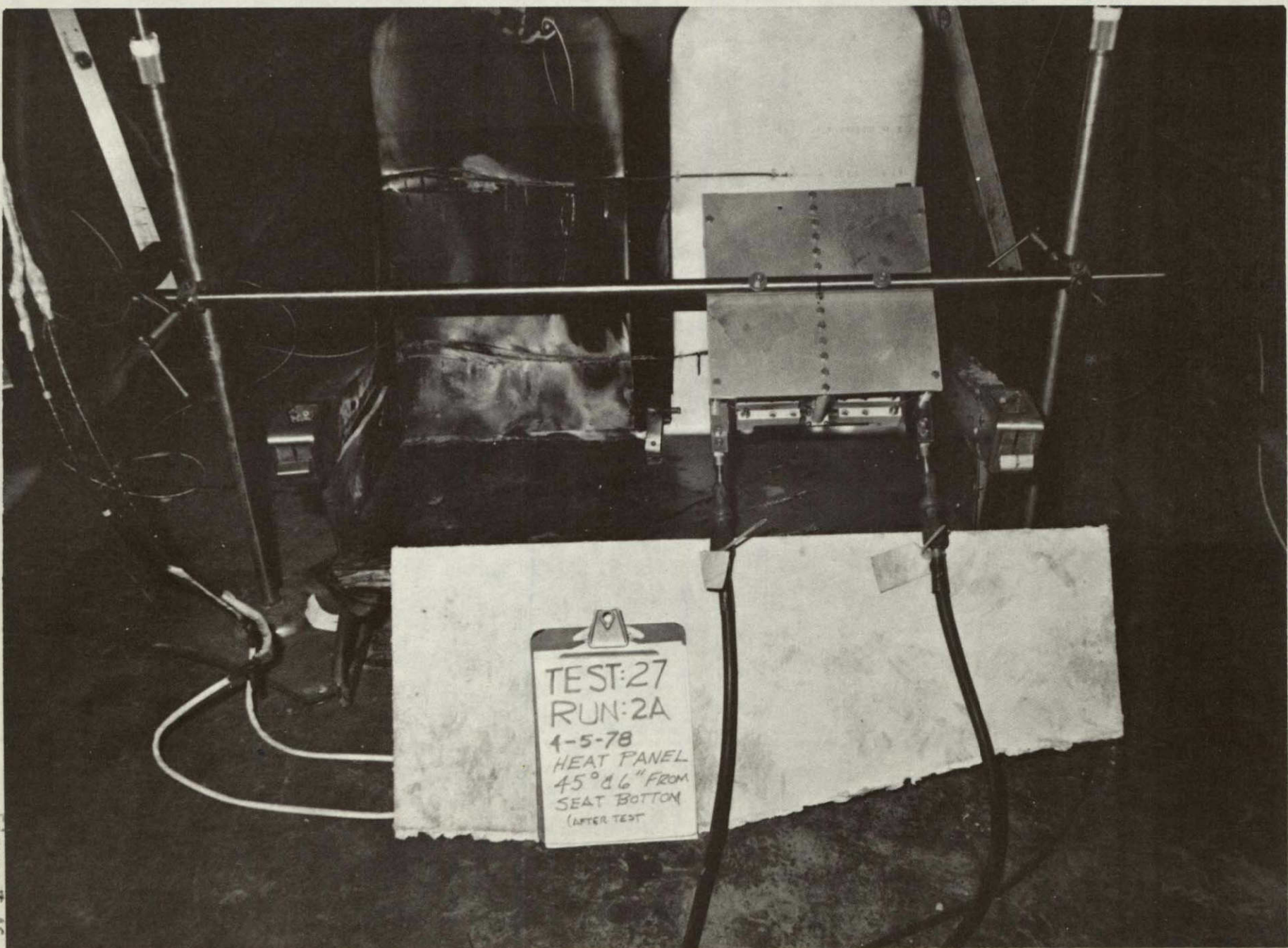
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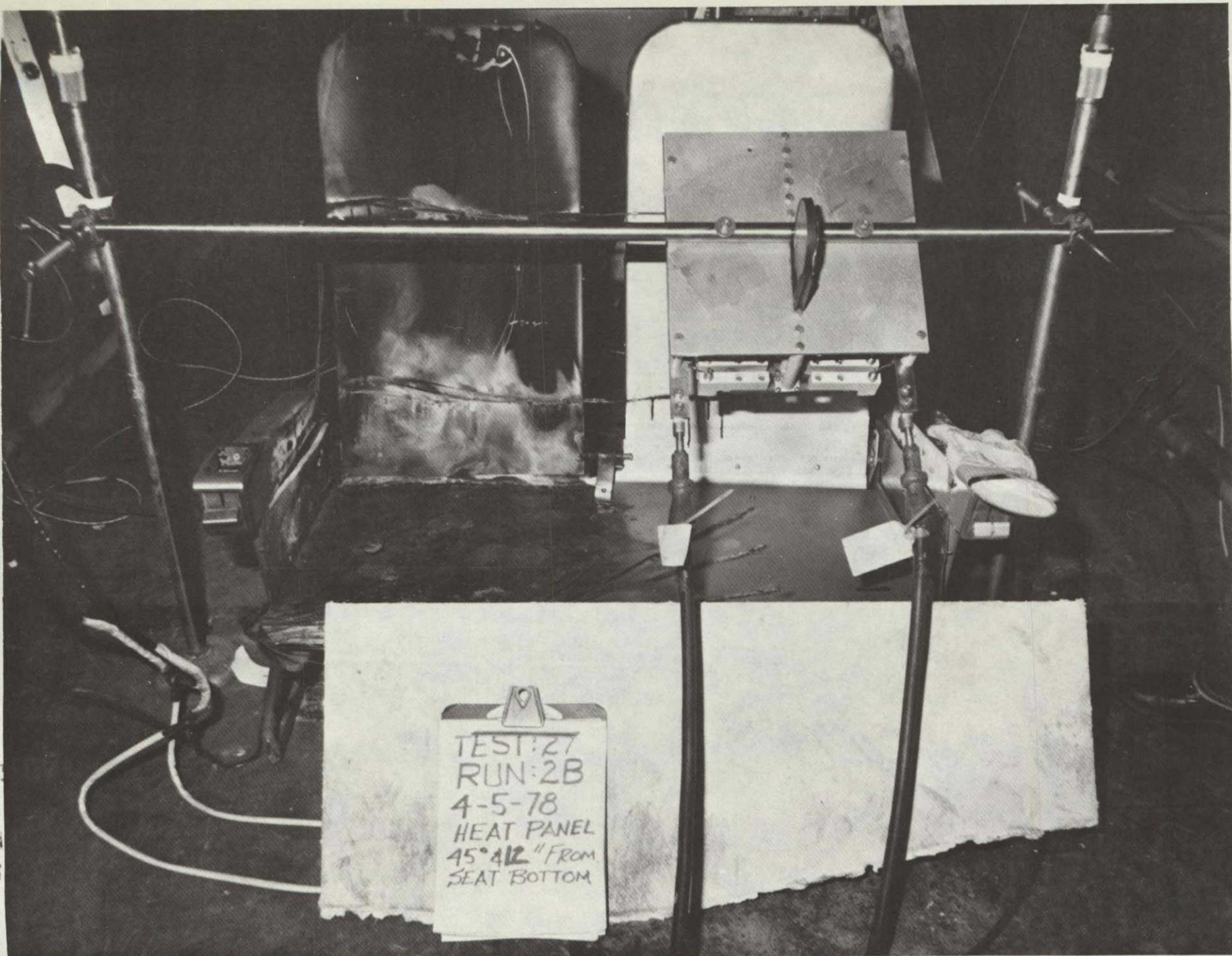
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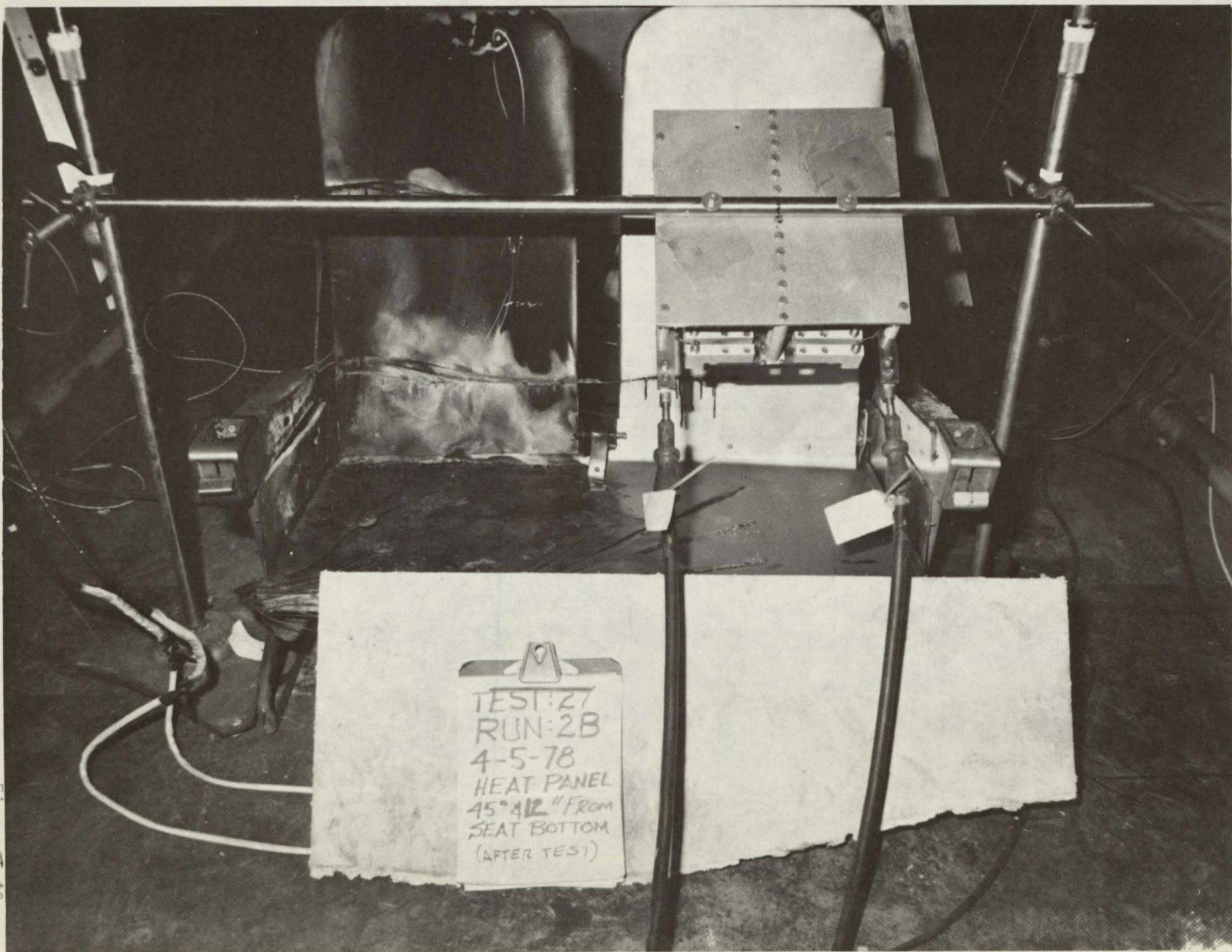
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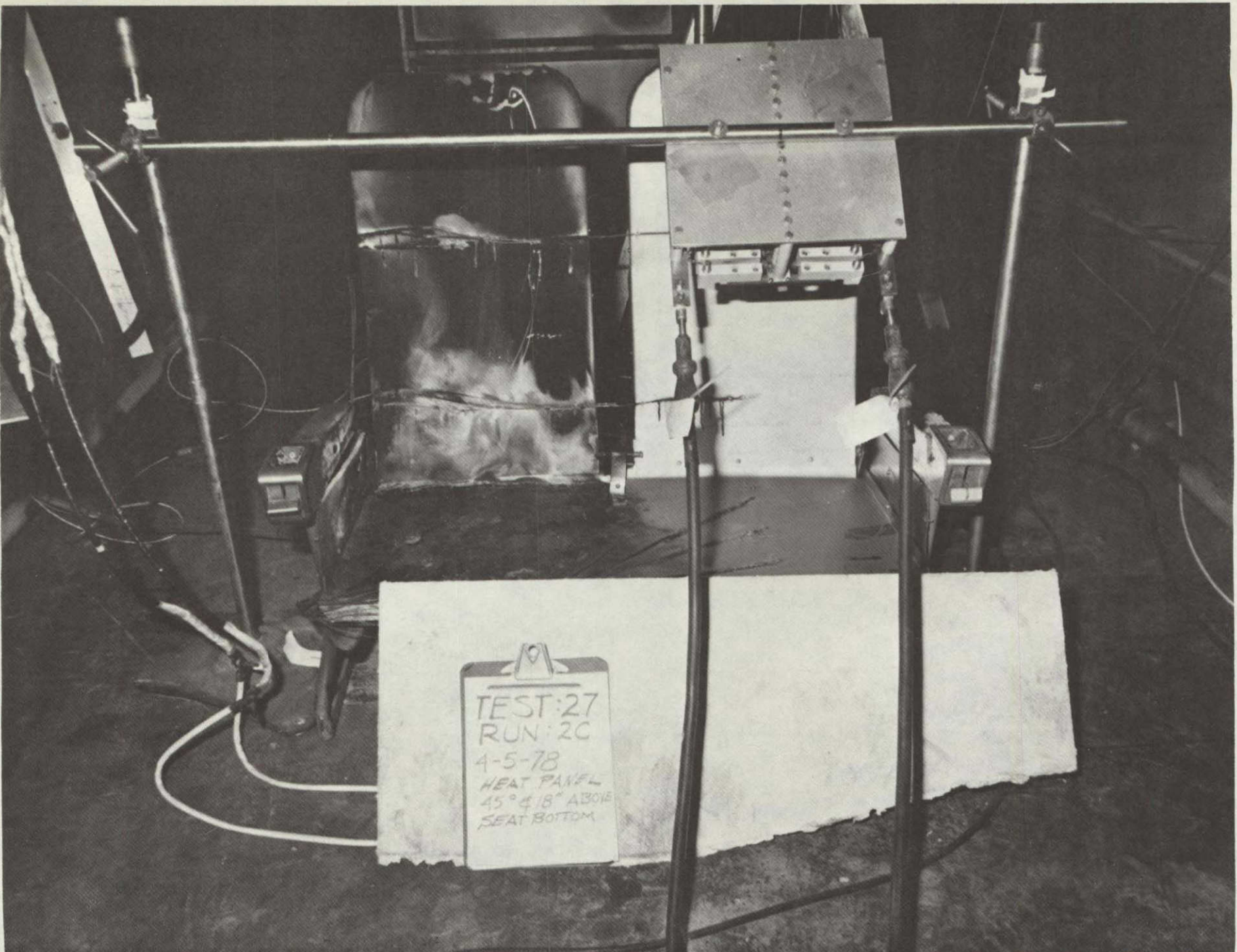
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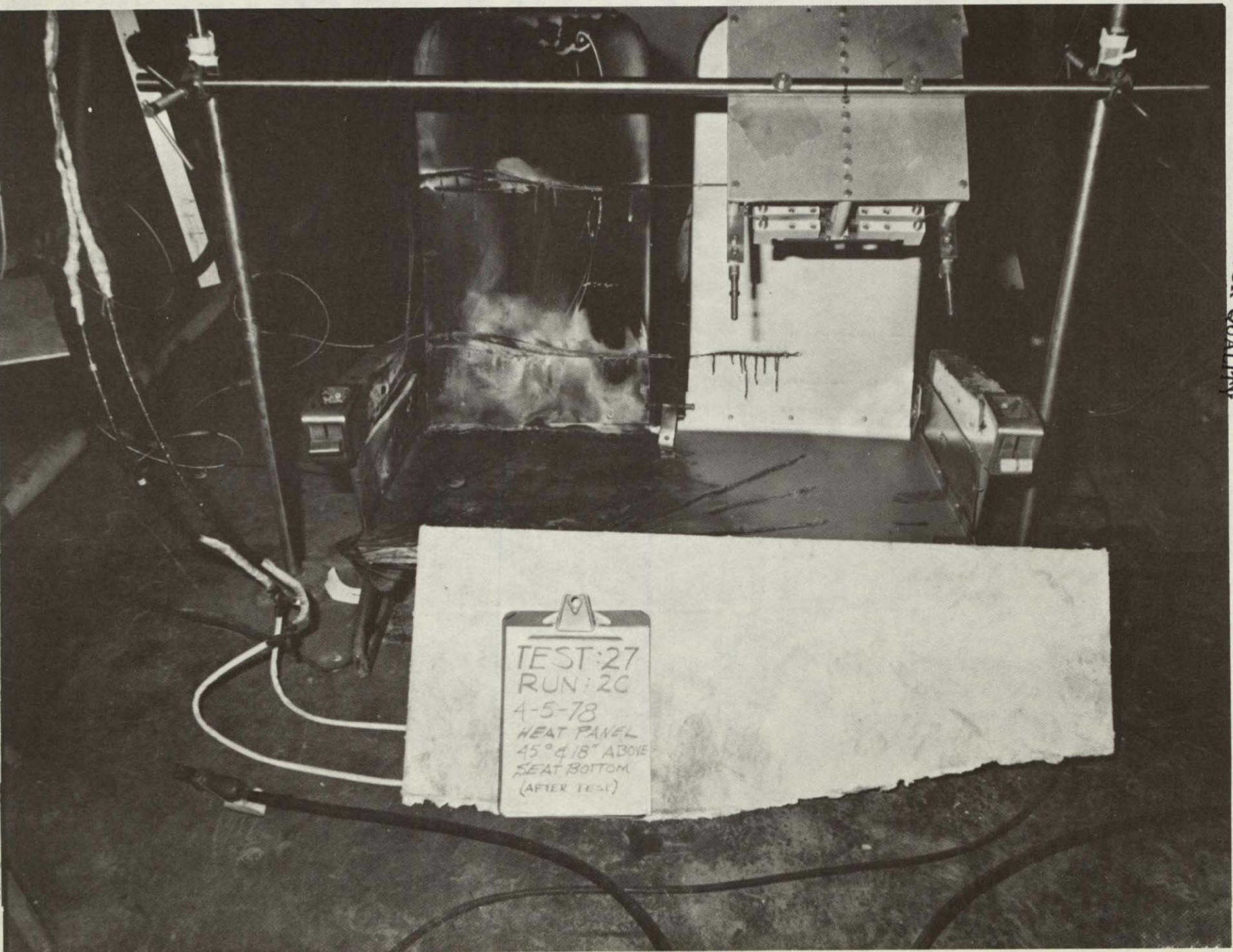
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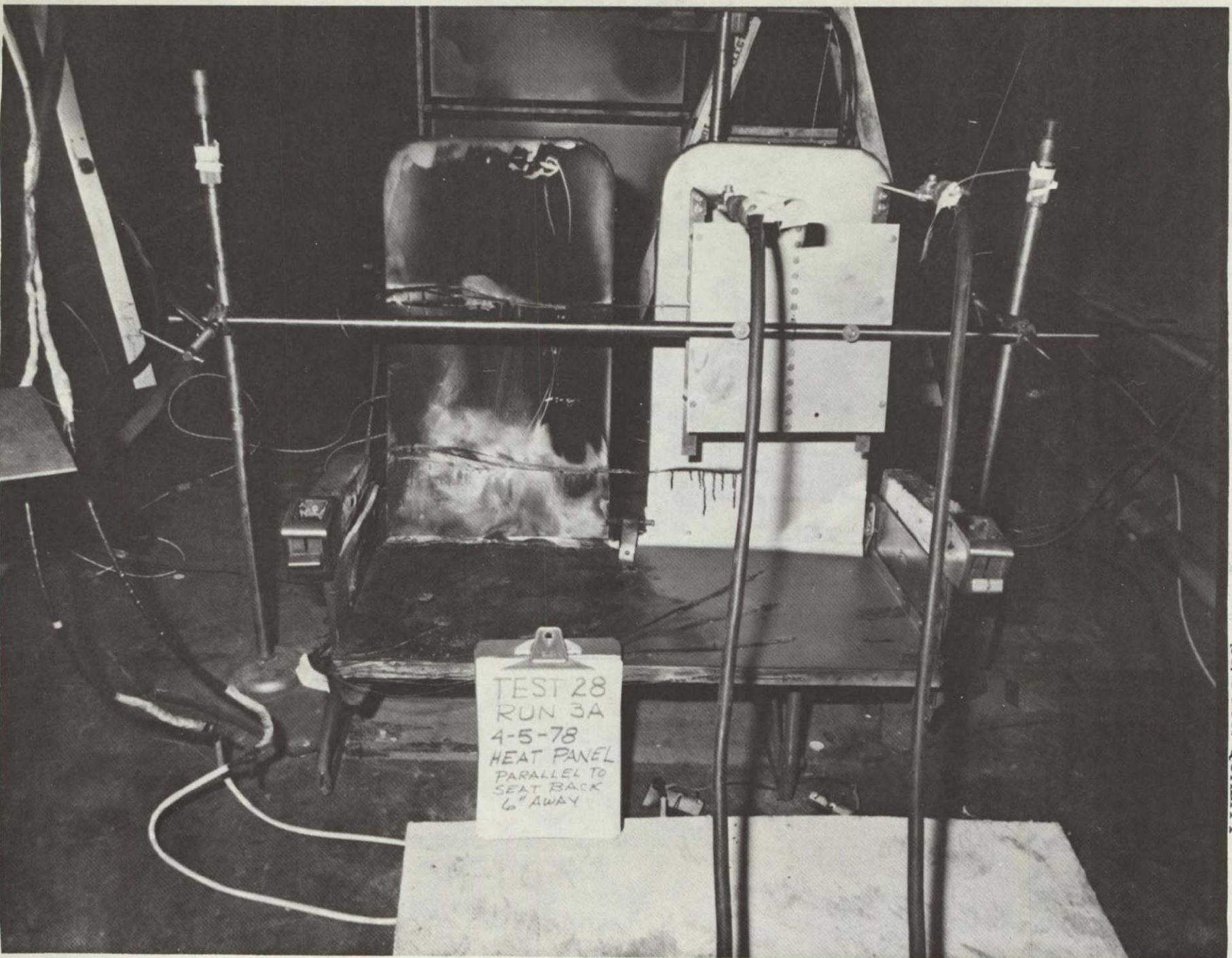
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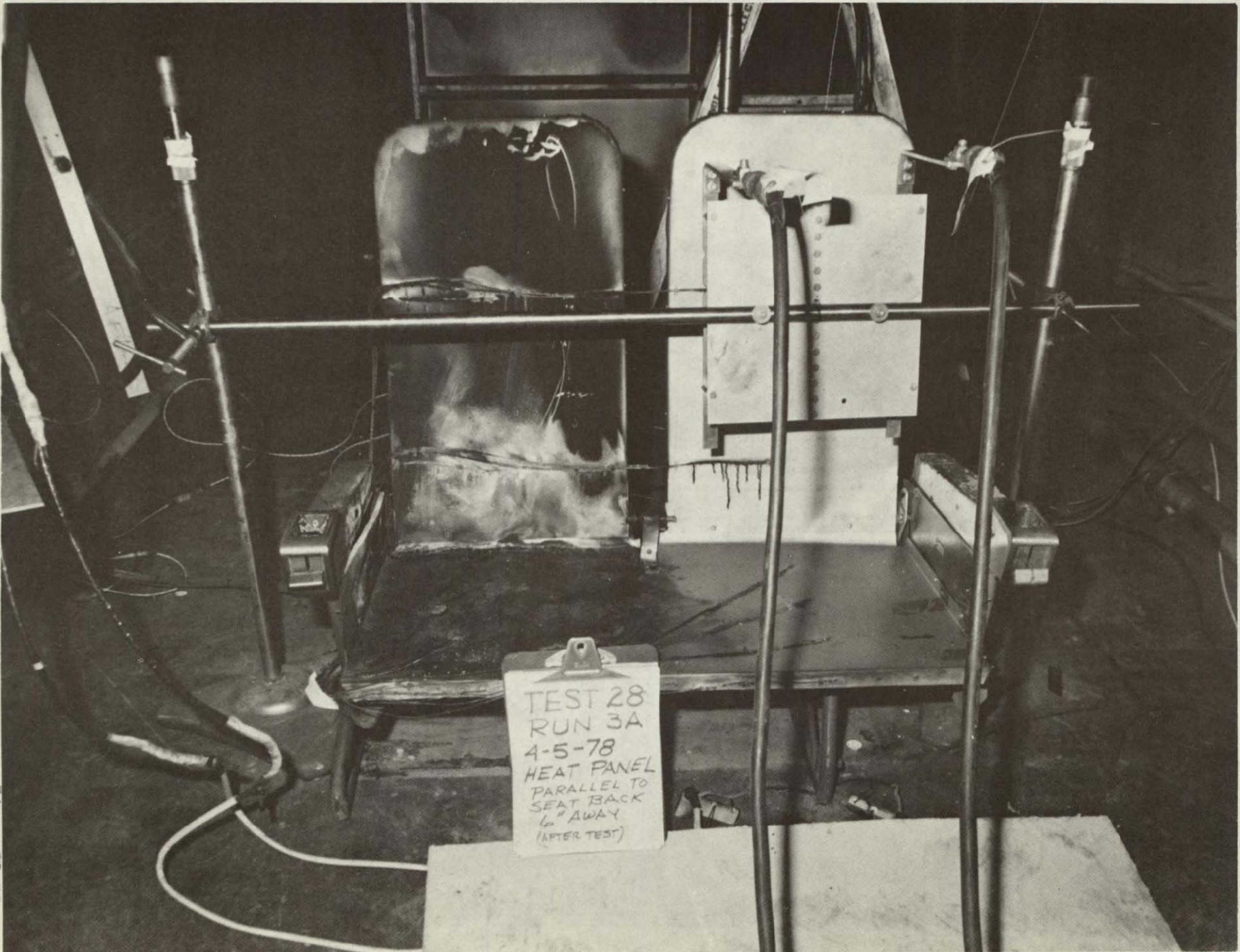
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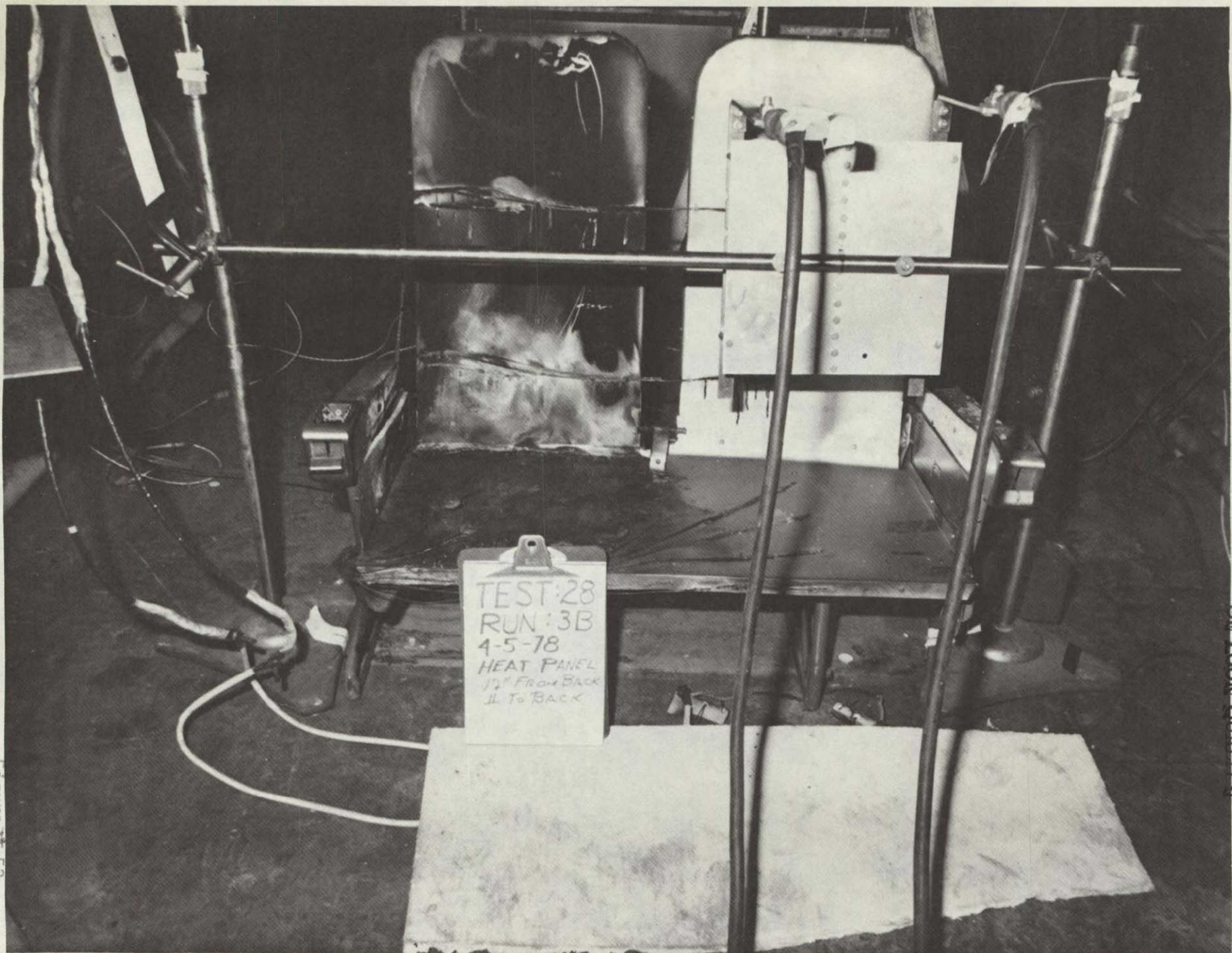
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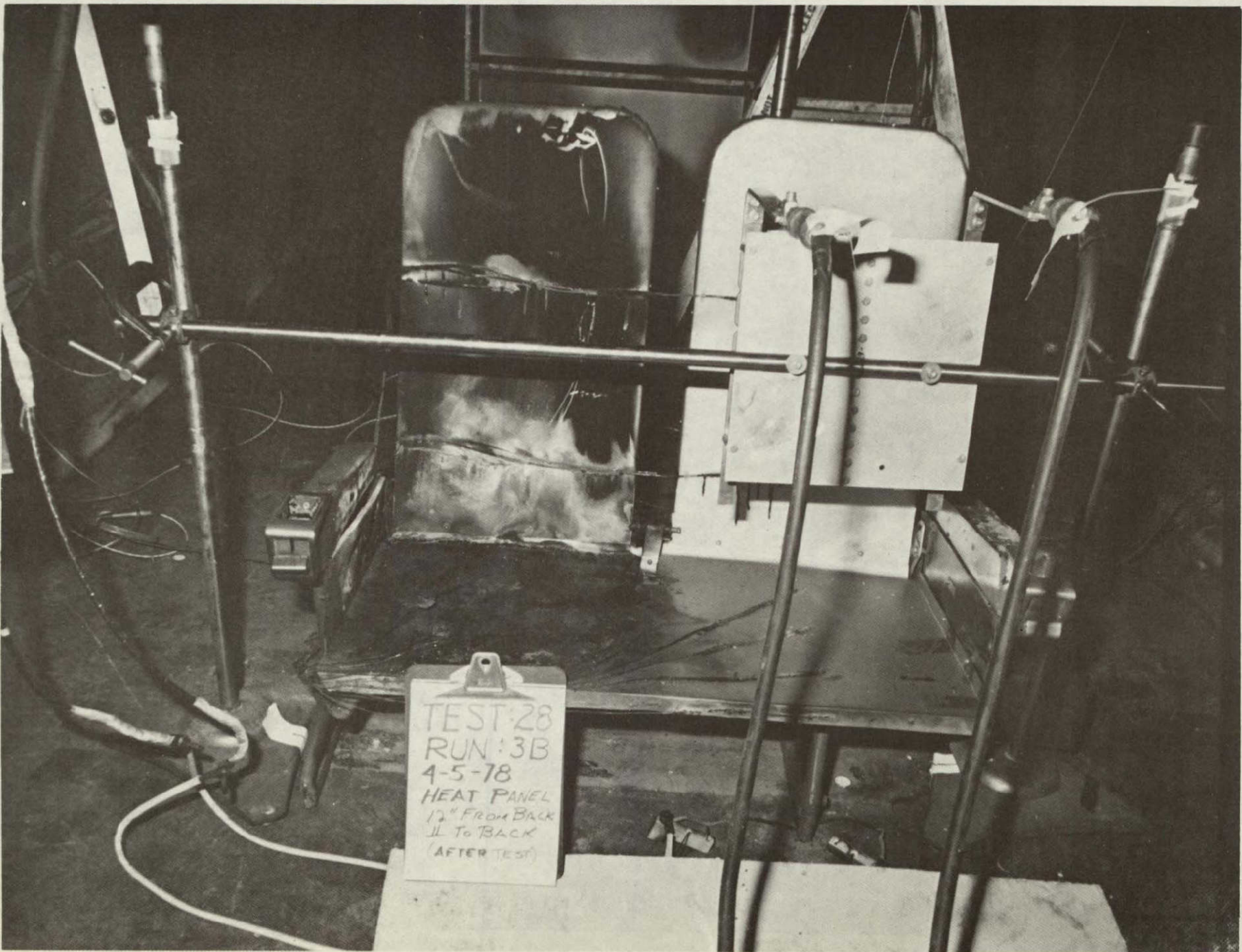
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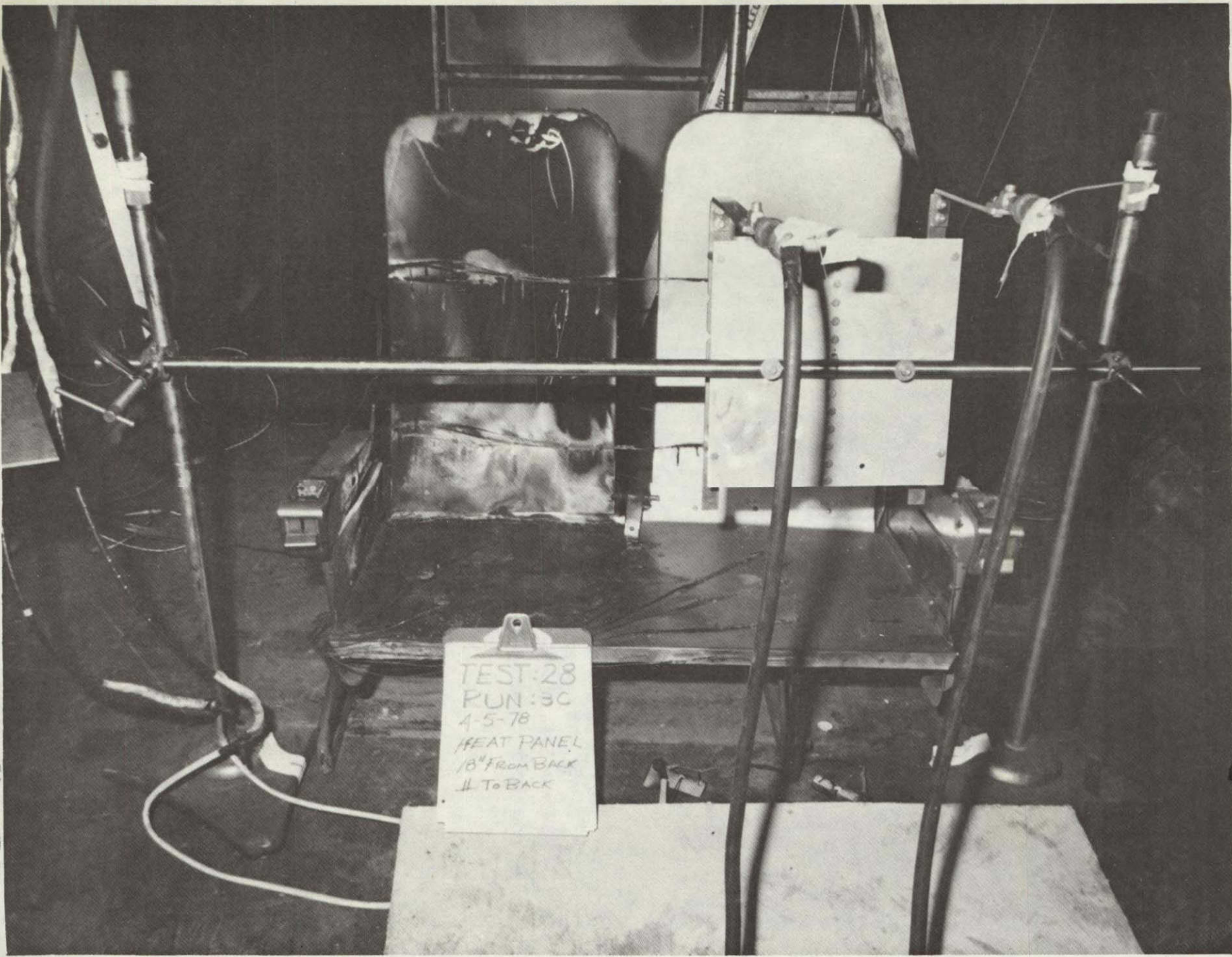
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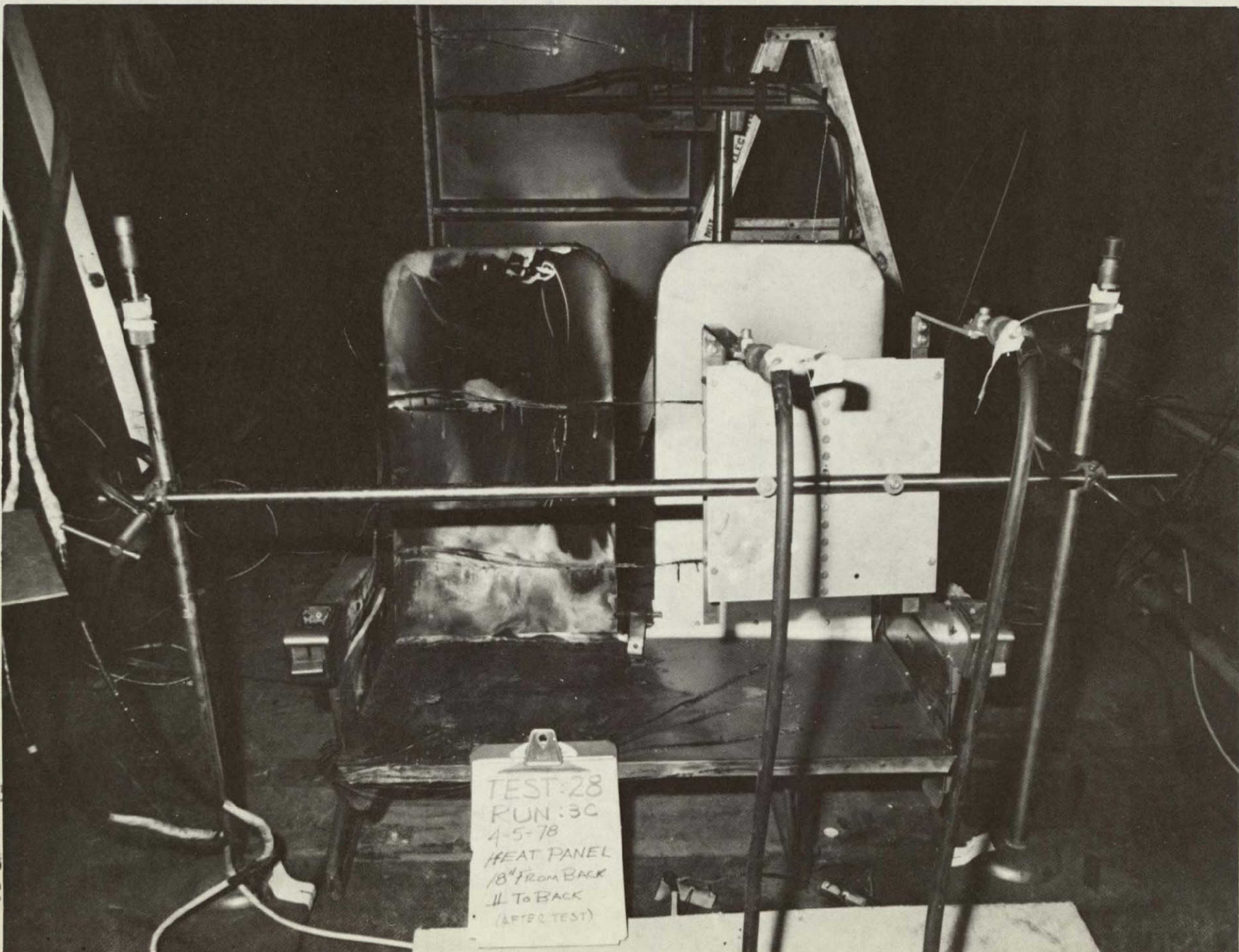
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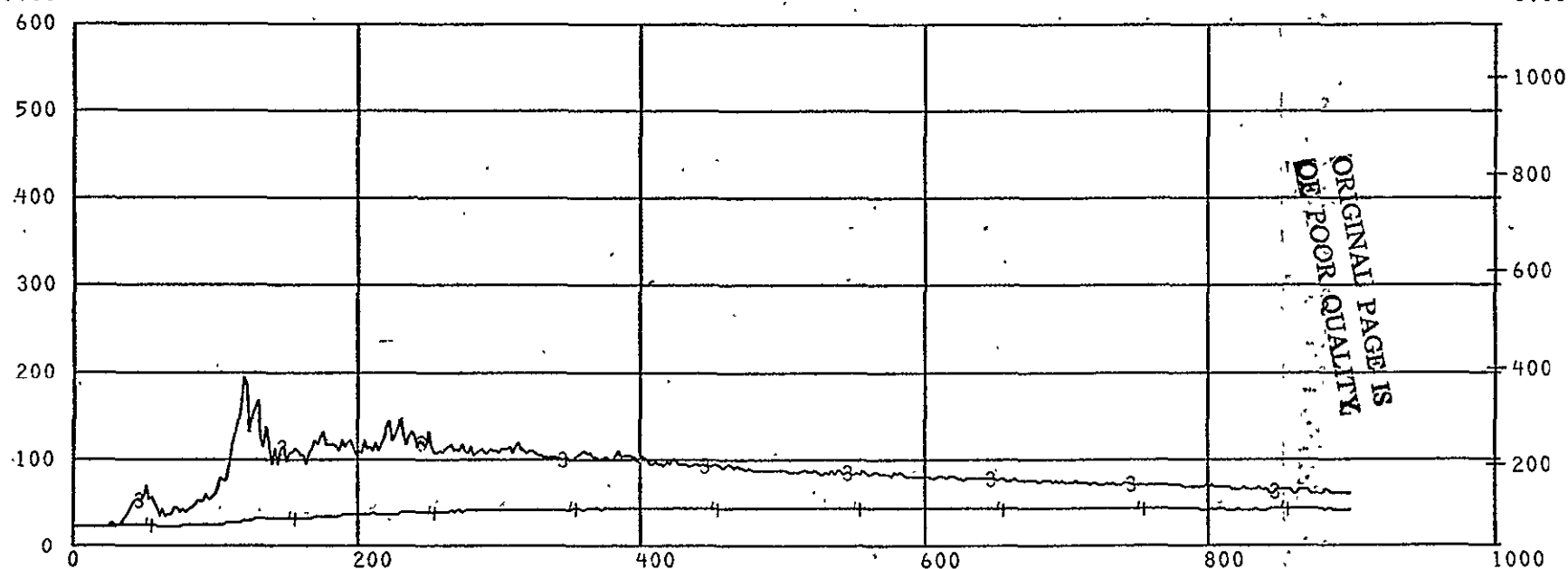
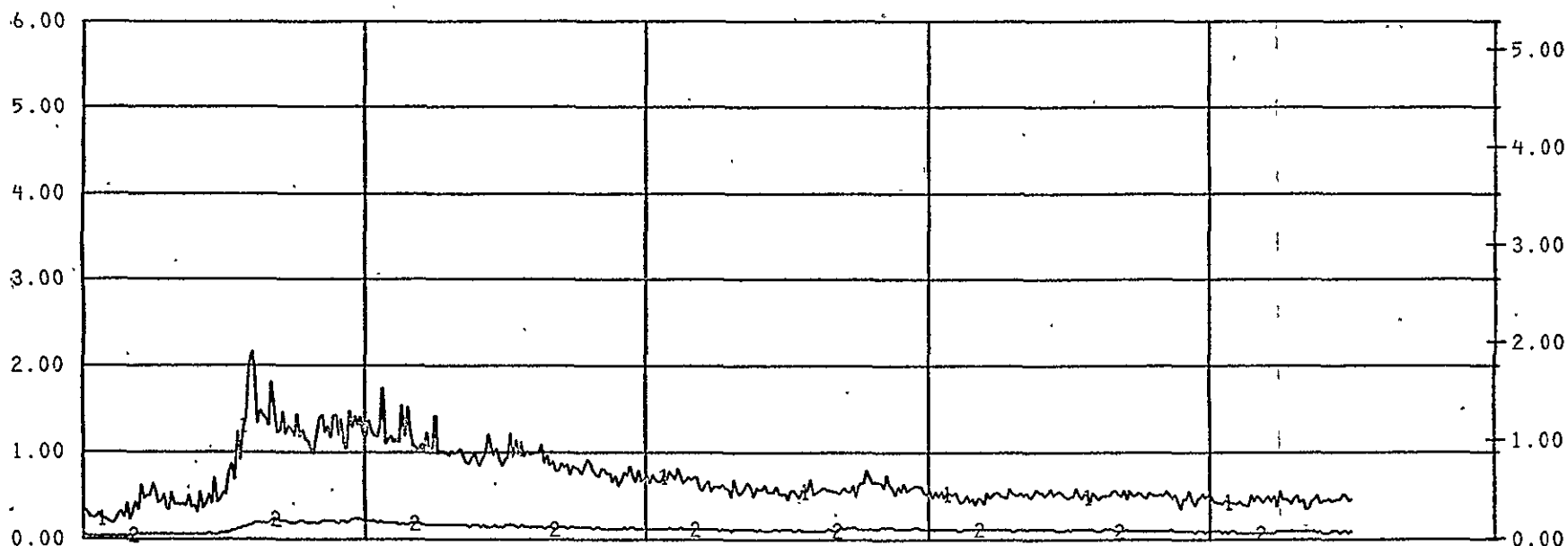


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APPENDIX III
SOURCE FIRE TEST DATA

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MEAS. NUMBER	CHANNEL ASGN.
\$ C1	
\$ C2	
\$ TC19	139
\$ TC20	120

TITLE
CALORIMETER OVER FIRE
CALORIMETER

RANGE
0.00 TO 6.00
0.00 TO 6.00
0 TO 600
0 TO 600

UNITS	GRID-SYM
WATT/CM2	A1
WATT/CM2	A2
DEG C	B3
DEG C	B4

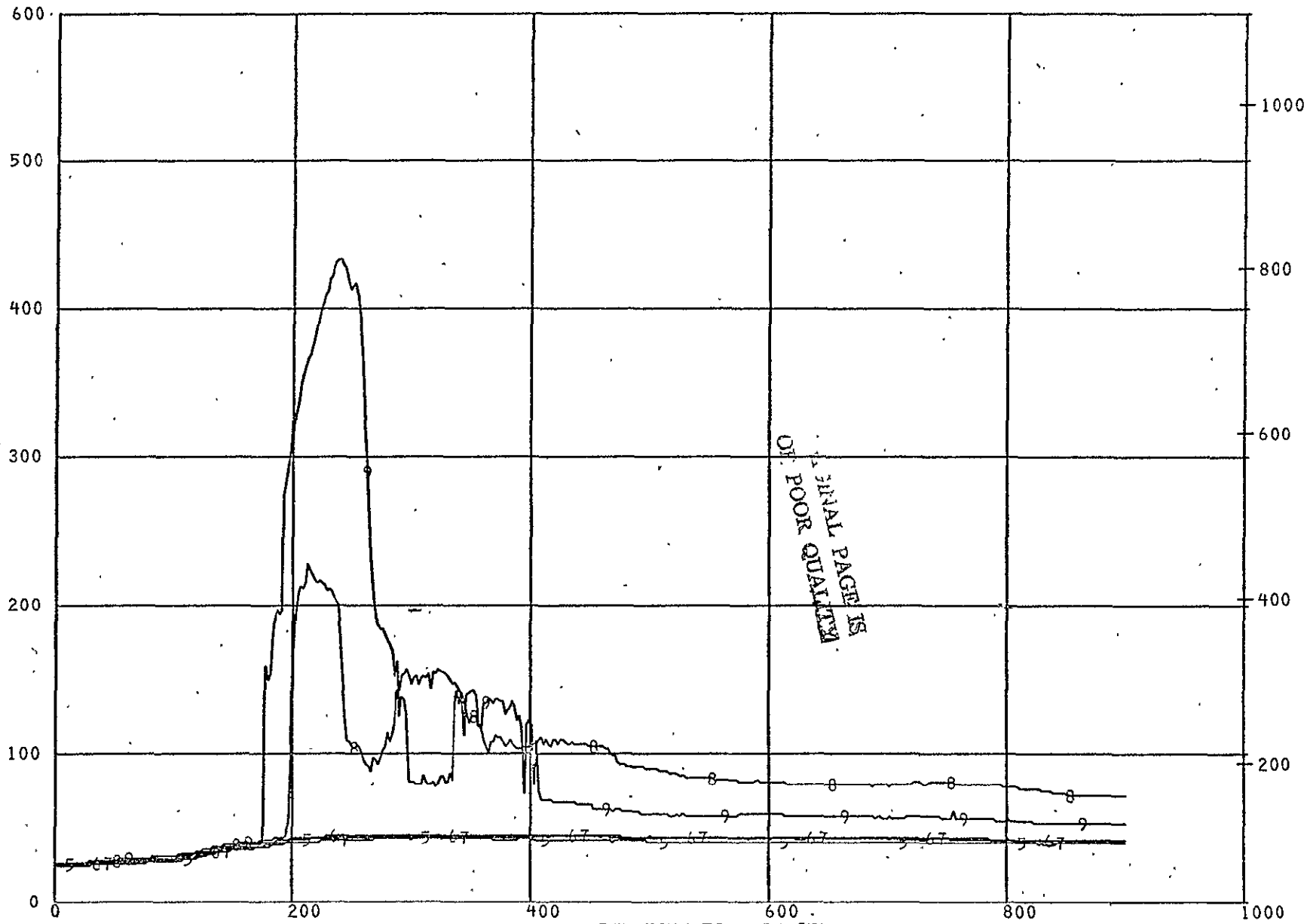
TEST ID 840288 081000

ST03

PLOT NO

2-- 1

REFERENCE TIME 09 23 01.000



MEAS. NUMBER . CHANNEL ASGN.

\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

TITLE

RANGE

0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

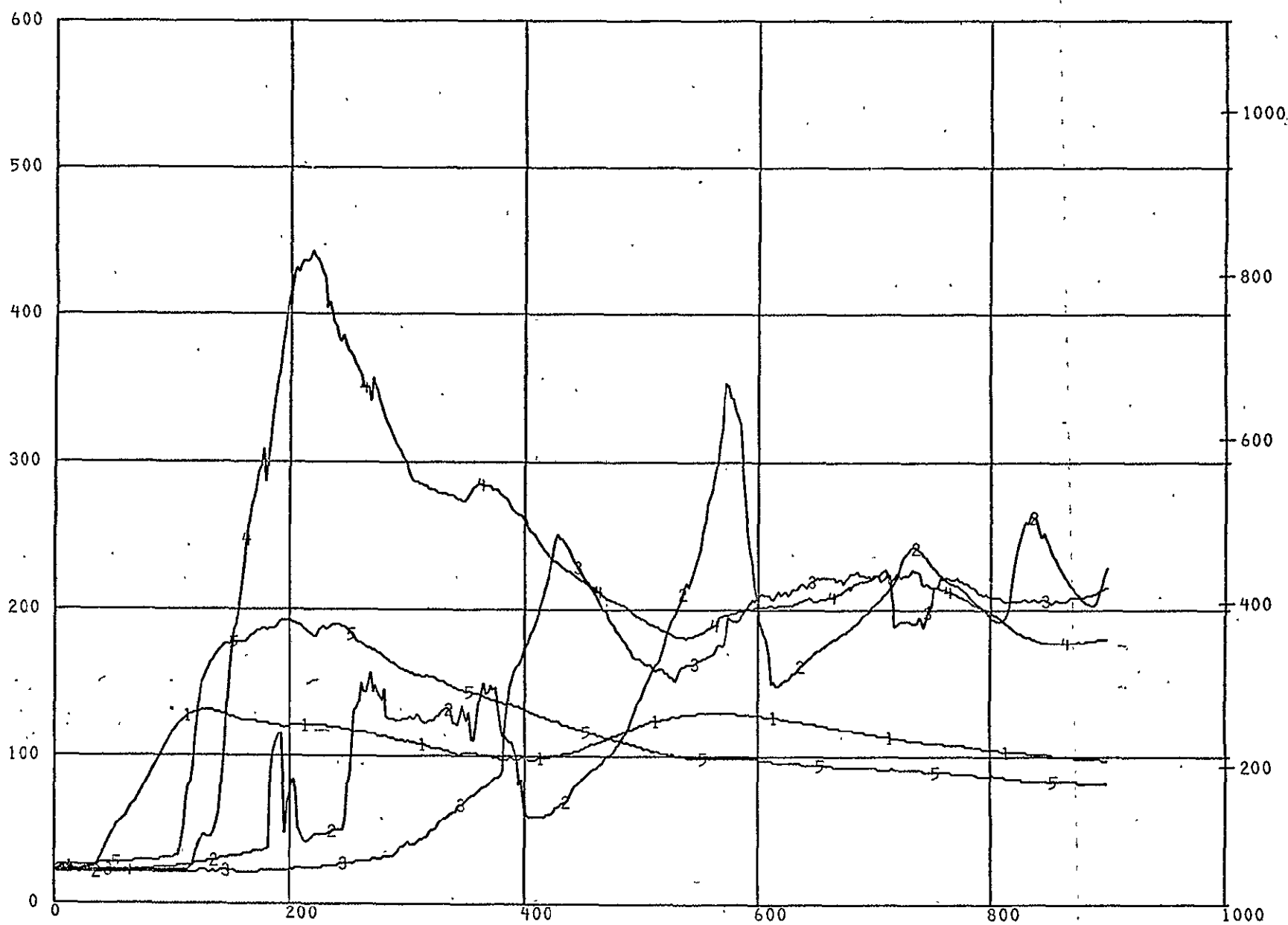
UNITS

DEG C
DEG C
DEG C
DEG C
DEG C

GRID-S..

A5
A6
A7
A8
A9

172



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

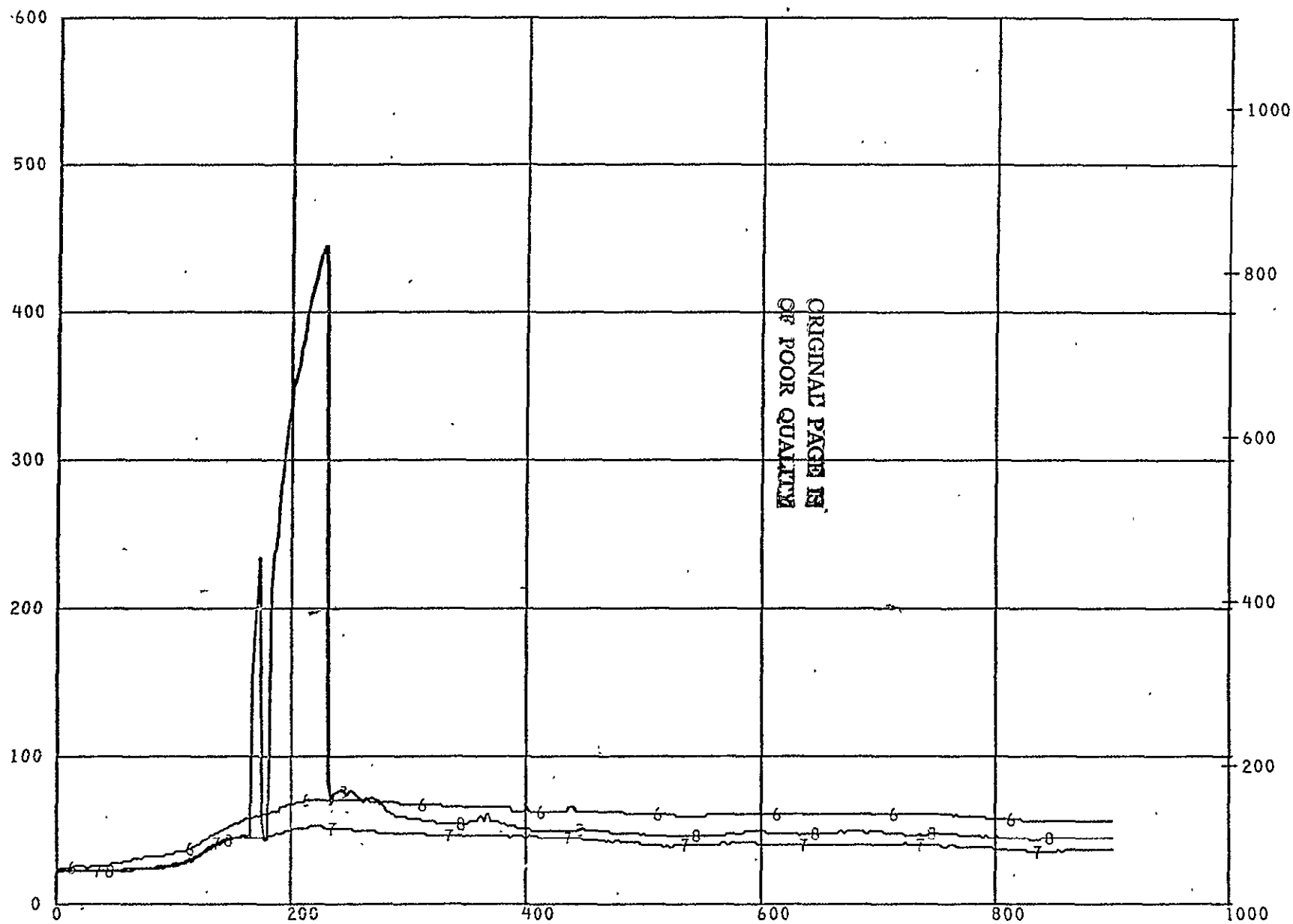
UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 081000

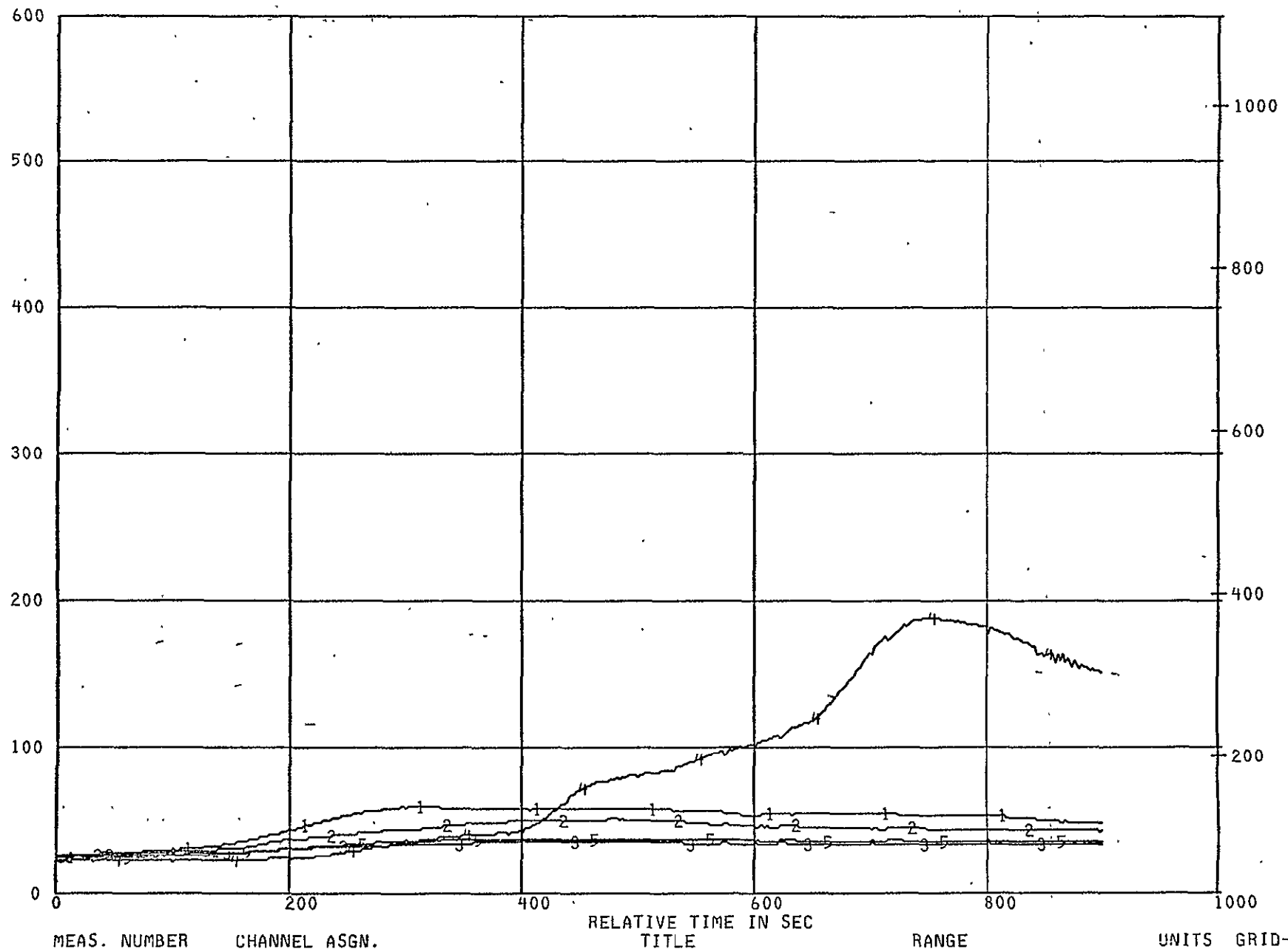
ST03

PLOT NO 4 - 1

REFERENCE TIME 09 23 01.000



TITLE



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

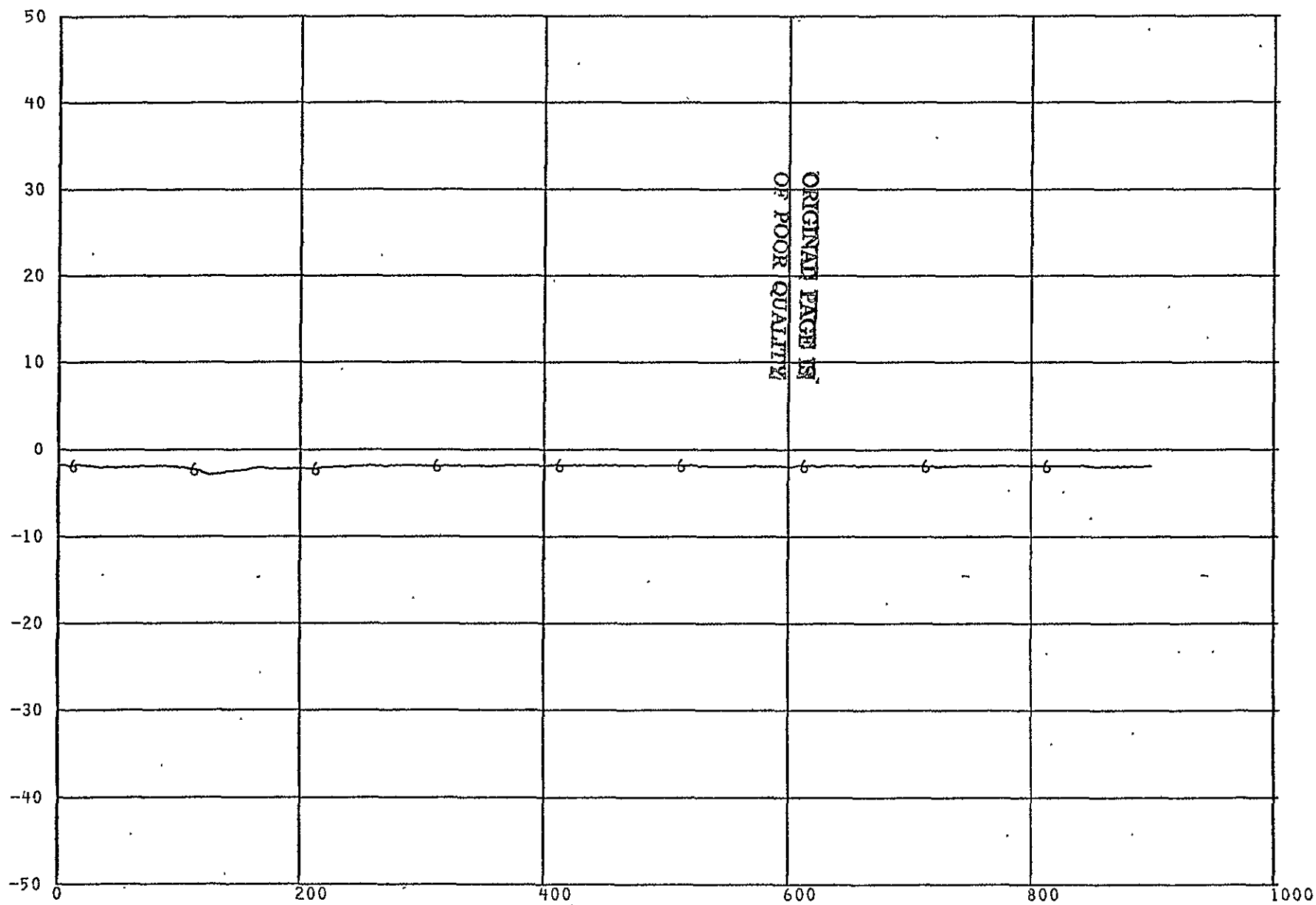
TEST ID 840288 081000

ST03

PLOT NO

6 - 1

REFERENCE TIME 09 23 01.000



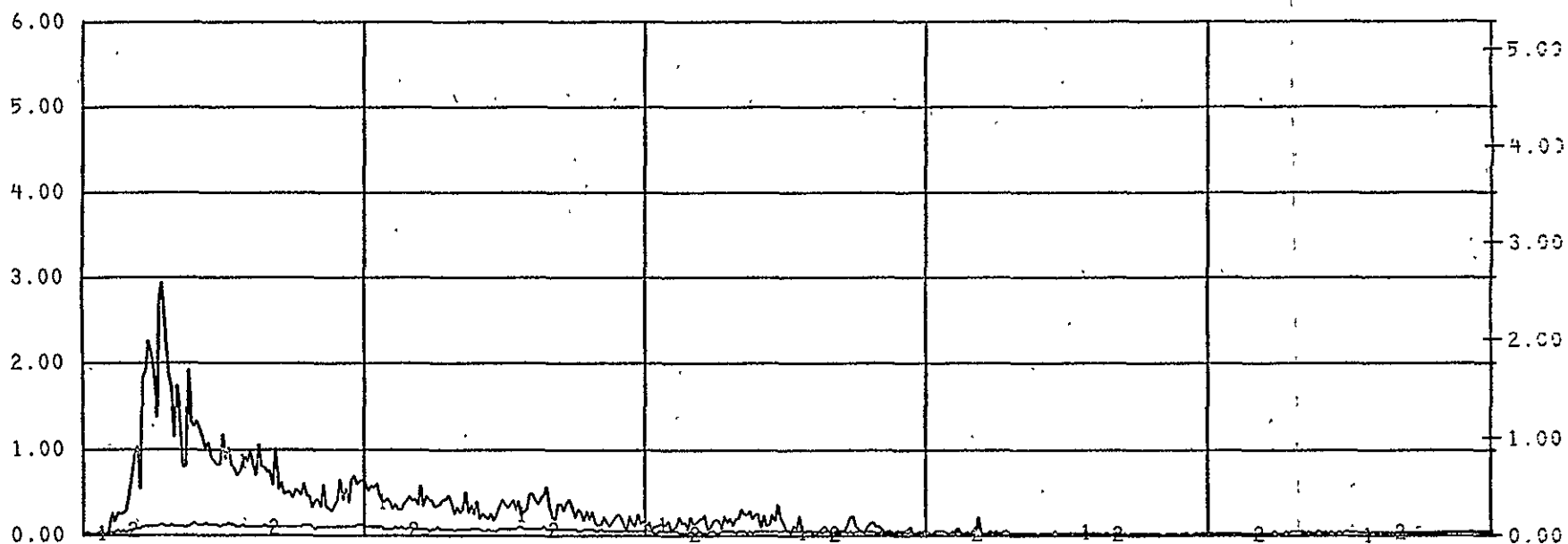
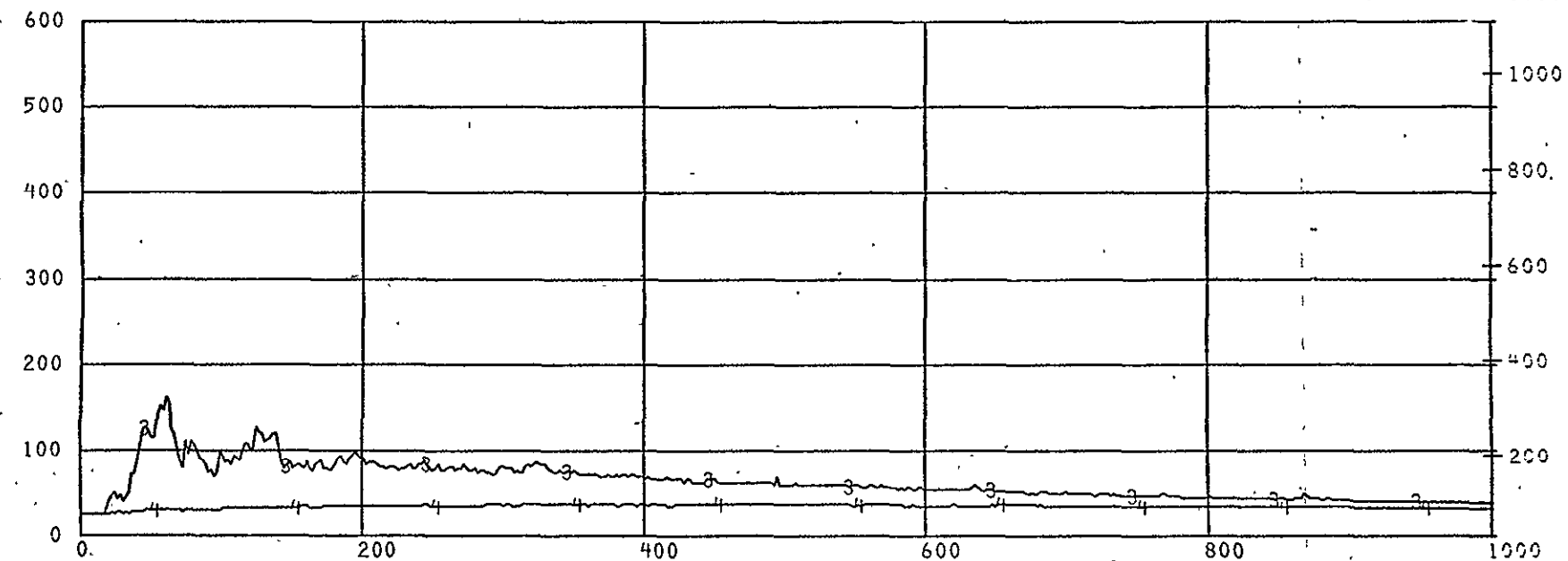
MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SY:
IN-H20 A6

B
T
U
/
F
2
SD
E
G
F

MEAS. NUMBER CHANNEL ASGN.
 \$ C1
 \$ C2
 \$ TC19 139
 \$ TC20 120

RELATIVE TIME IN SEC
 TITLE
 CALORIMETER OVER FIRE
 CALORIMETER

RANGE
 0.00 TO 6.00
 0.00 TO 6.00
 0 TO 600
 0 TO 600

UNITS SPID-SYM
 WATT/CM2 A1
 WATT/CM2 A2
 DEG C B3
 DEG C B4

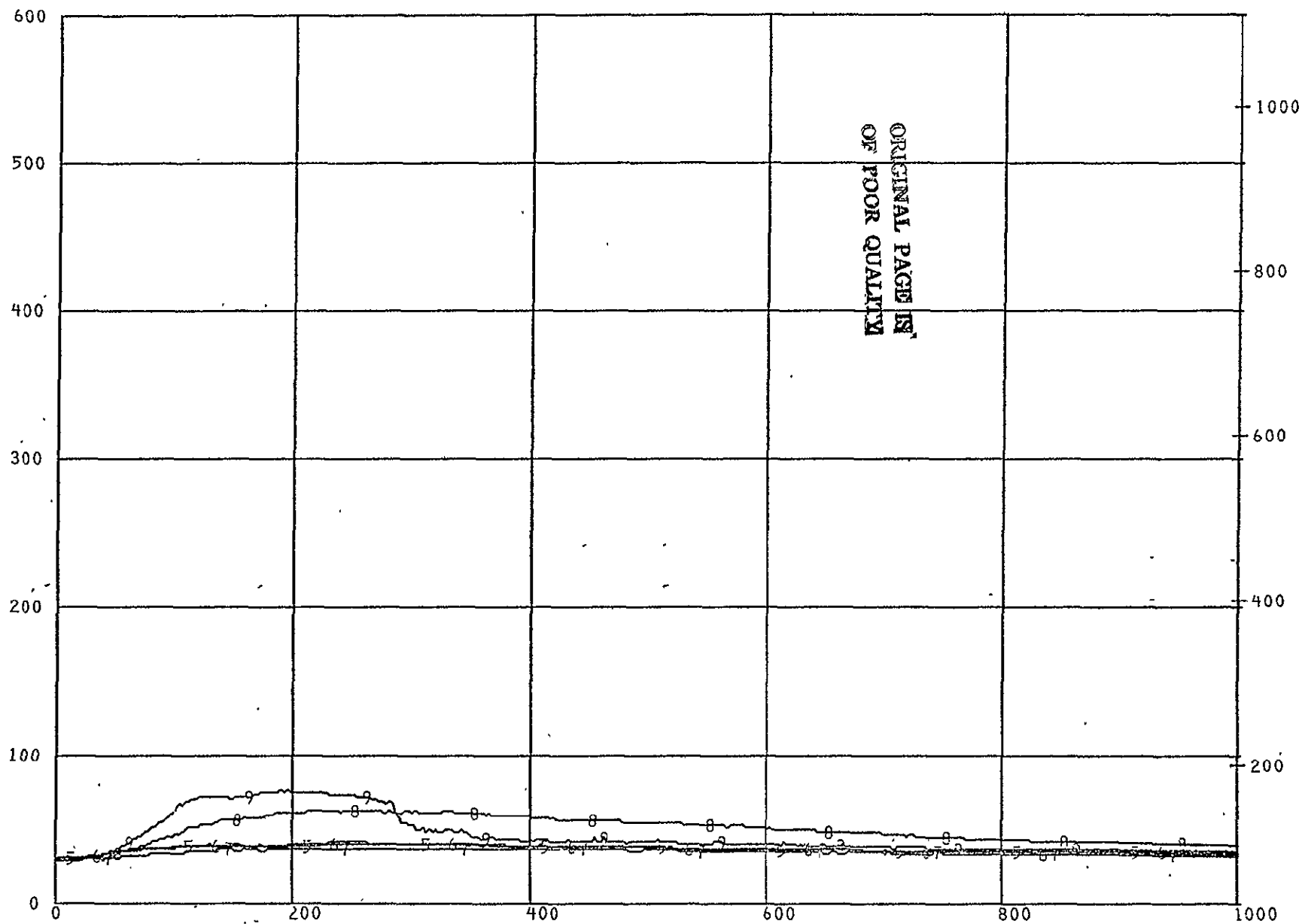
TEST ID 840288 081000

ST2A

PLOT NO

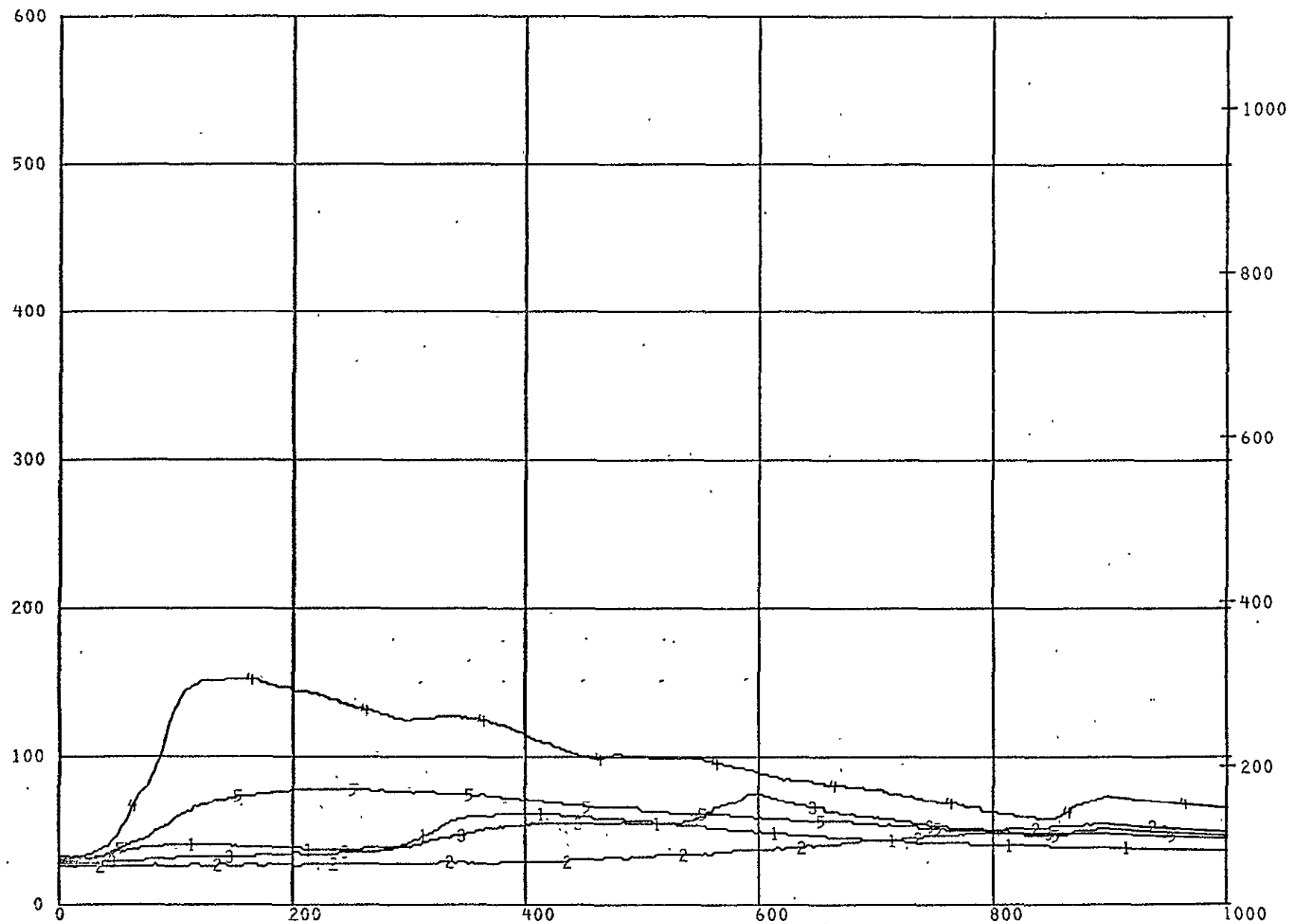
2 - 1

REFERENCE TIME 14 38 01.000



GUCO L

MEAS. NUMBER	CHANNEL ASGN.	TITLE	RANGE	UNITS	GRID-SYM
\$ TC05	105		0 TO 600	DEG C	A5
\$ TC06	106		0 TO 600	DEG C	A6
\$ TC07	107		0 TO 600	DEG C	A7
\$ TC12	132		0 TO 600	DEG C	A8
\$ TC13	133		0 TO 600	DEG C	A9



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

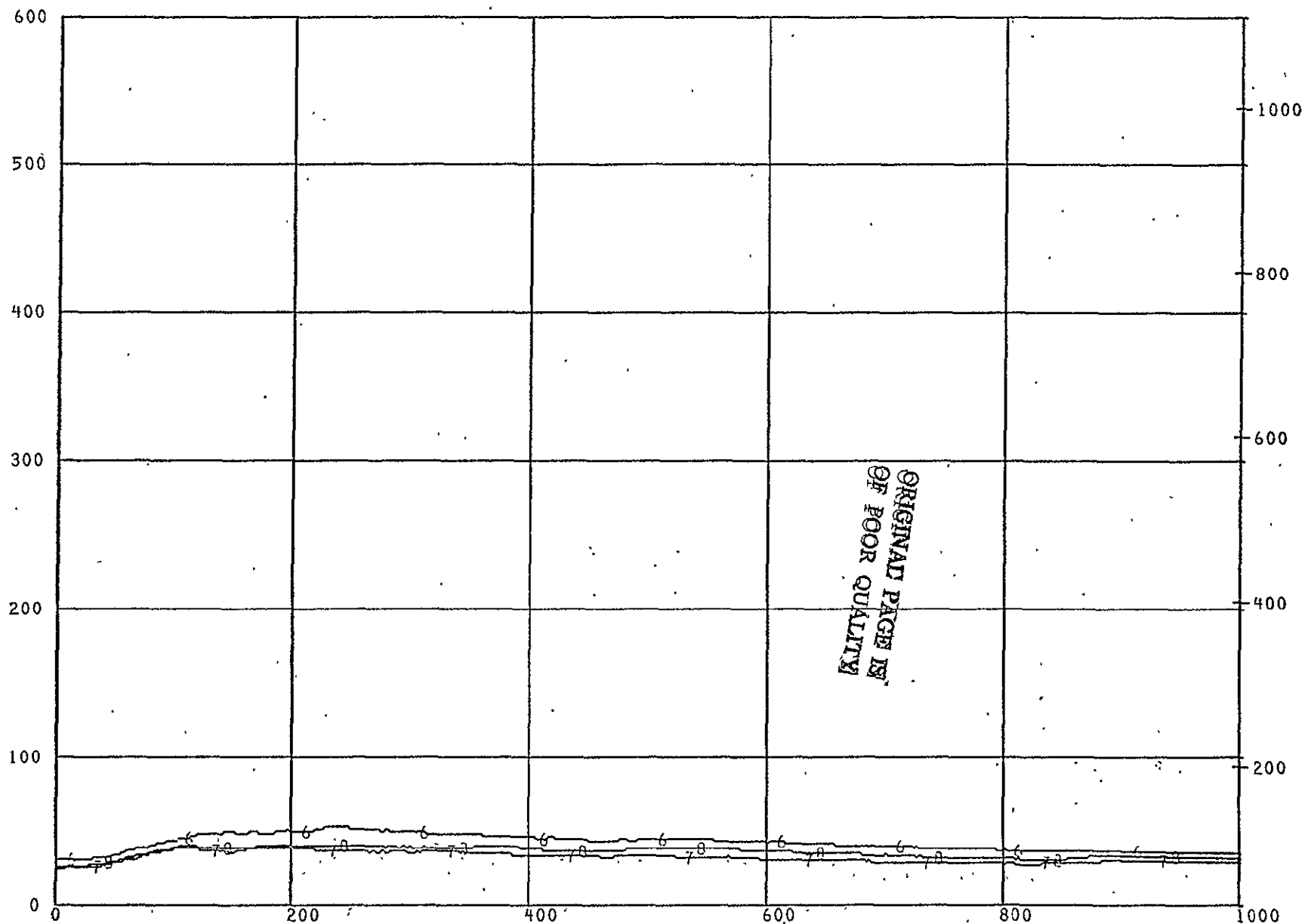
TEST ID 840288 081000

ST2A

PLOT NO

4 - 1

REFERENCE TIME 14 38 01.000



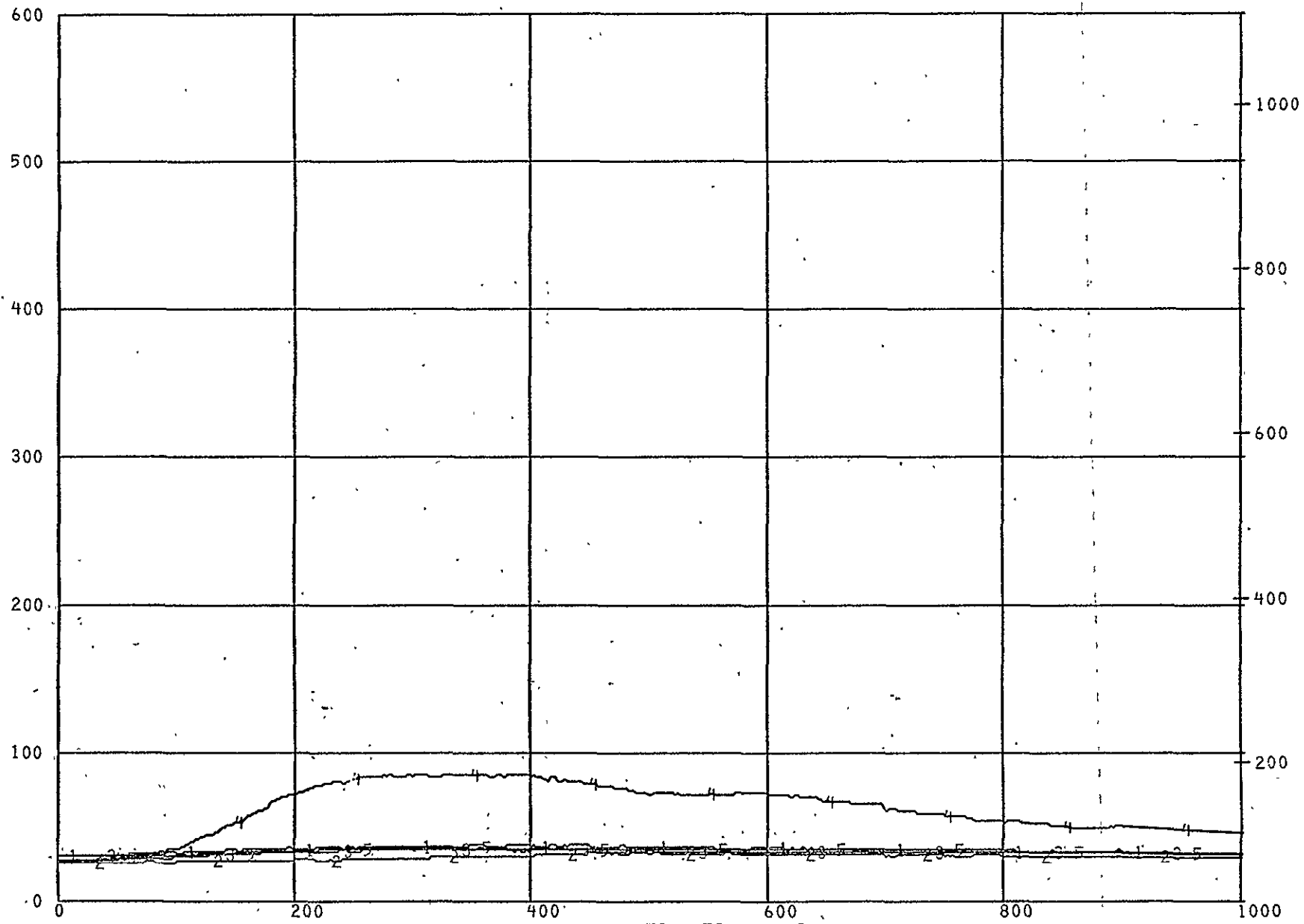
MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

180

D
E
G
C

MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

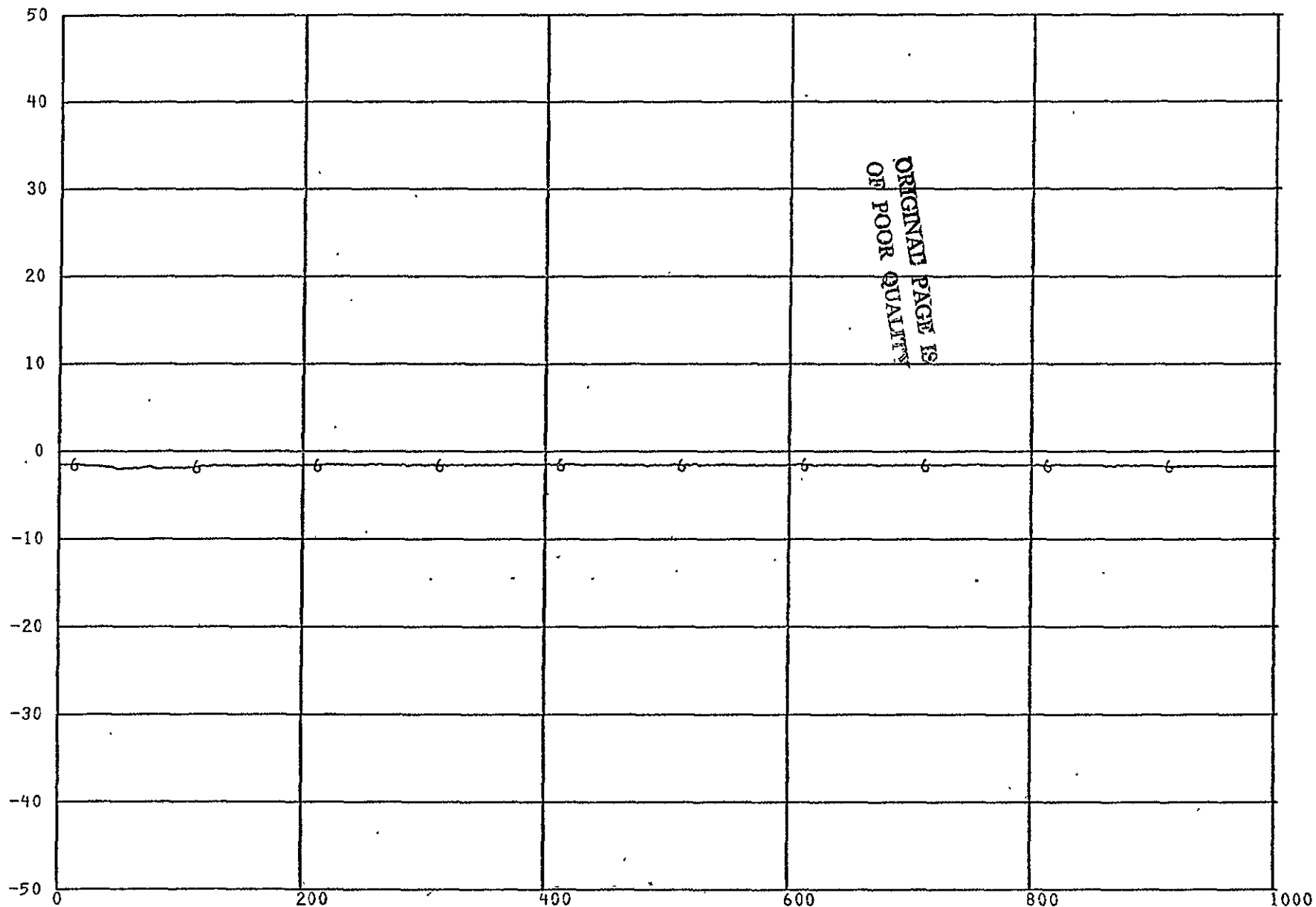
TEST ID 840288 081000

ST2A

PLOT NO

6 - 1

REFERENCE TIME 14 38 01.000



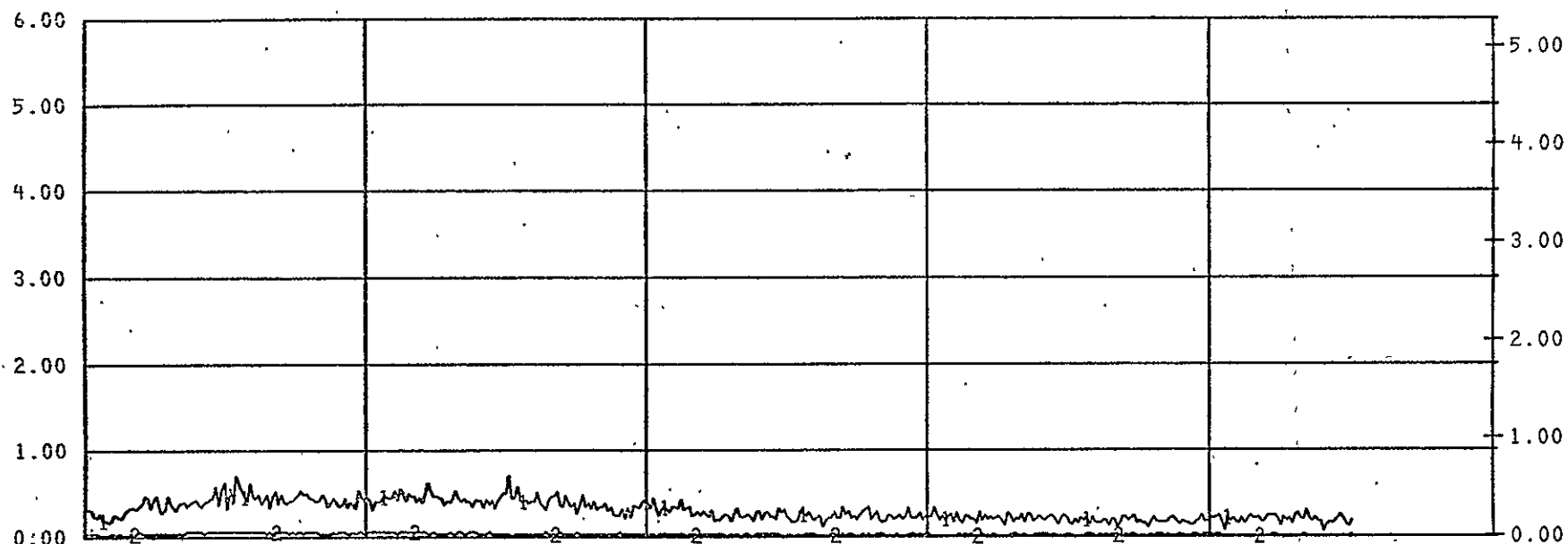
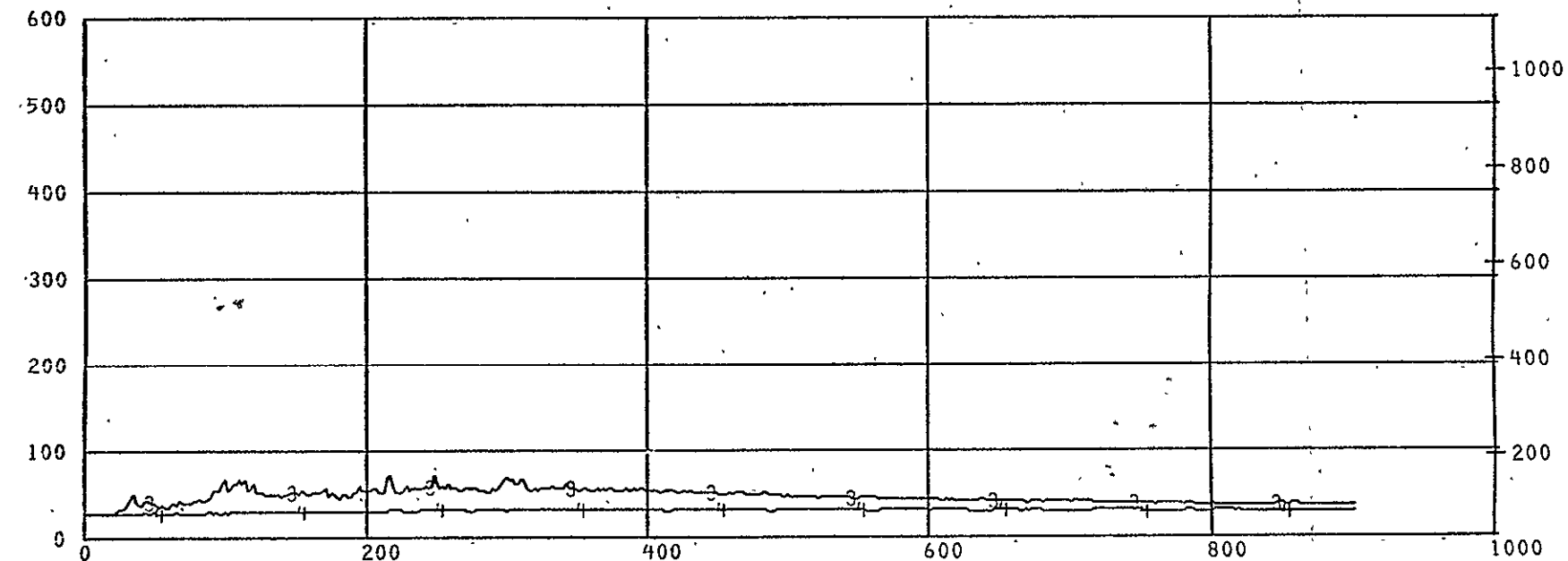
MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
1N-H20 A6

B
T
U
/
F
2
SD
E
G
C

RELATIVE TIME IN SEC

MEAS. NUMBER	CHANNEL ASGN.
\$ C1	
\$ C2	
\$ TC19	139
\$ TC20	120

TITLE
CALORIMETER OVER FIRE
CALORIMETER

RANGE
0.00 TO 6.00
0.00 TO 6.00
0 TO 600
0 TO 600

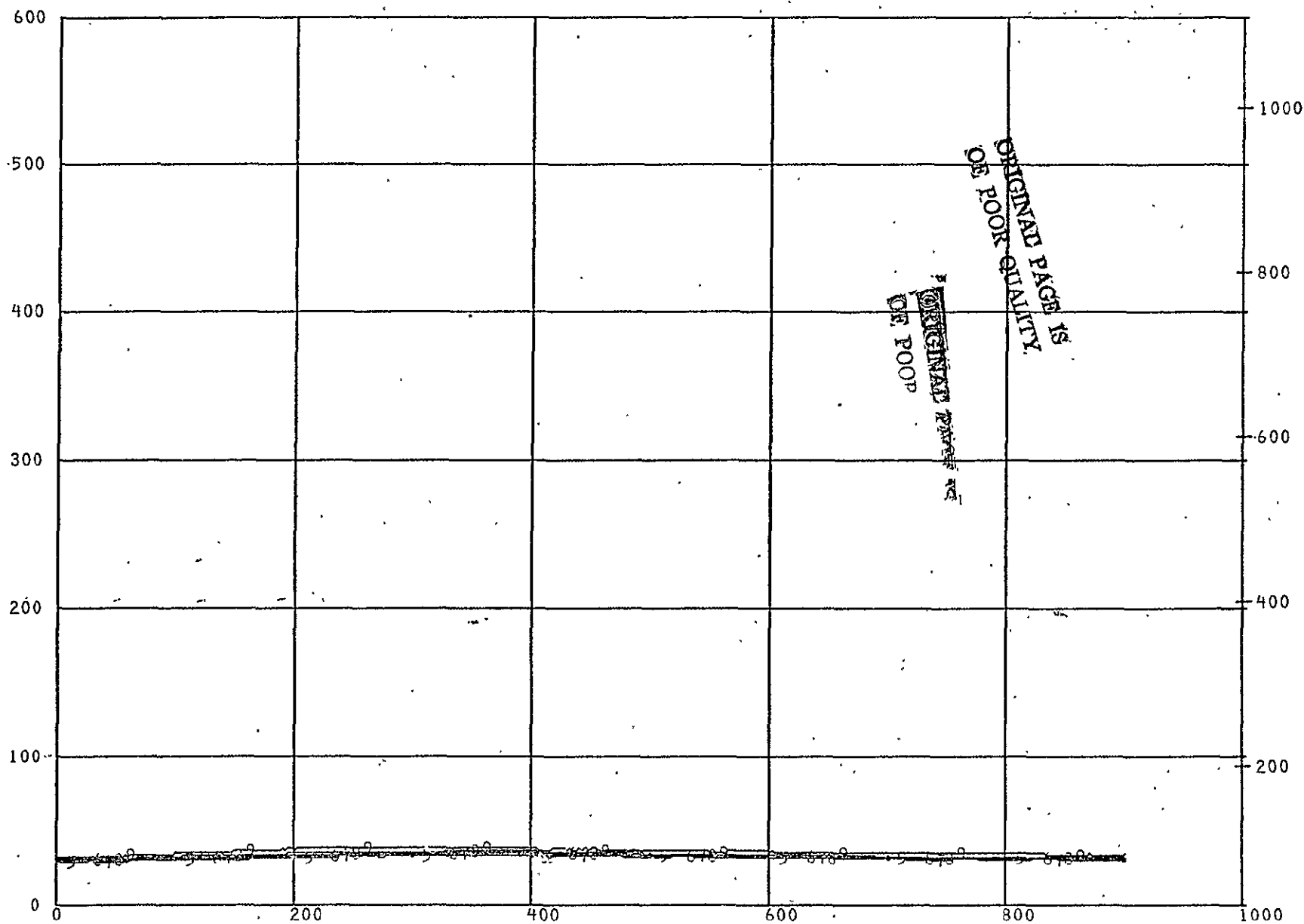
UNITS	GRID-SYM
WATT/CM2	A1
WATT/CM2	A2
DEG C	B3
DEG C	B4

TEST ID 840288 081000

ST01

PLOT NO 2 - 1

REFERENCE TIME 15 02 00.000

D
E
G
F

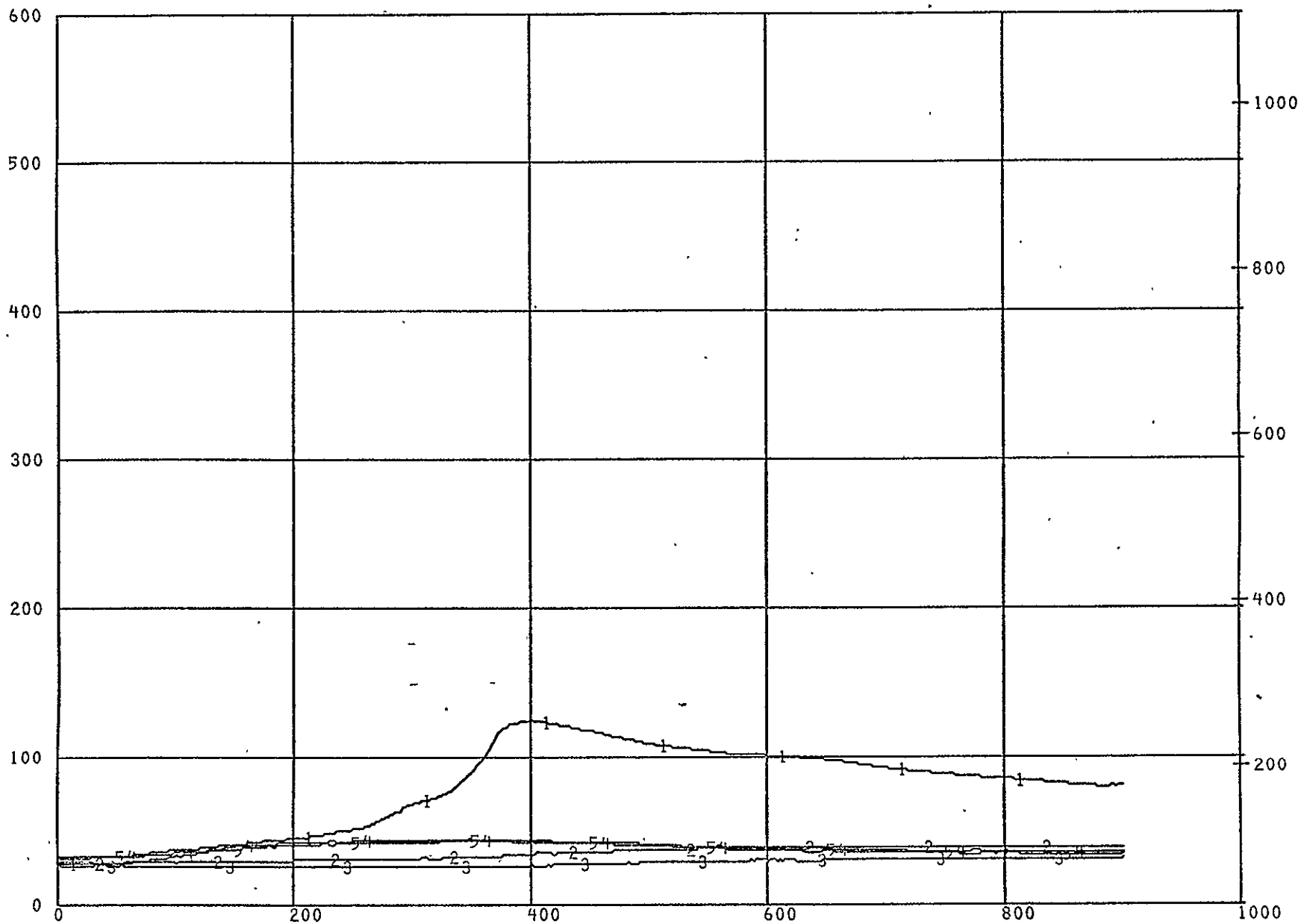
MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

184



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SUM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

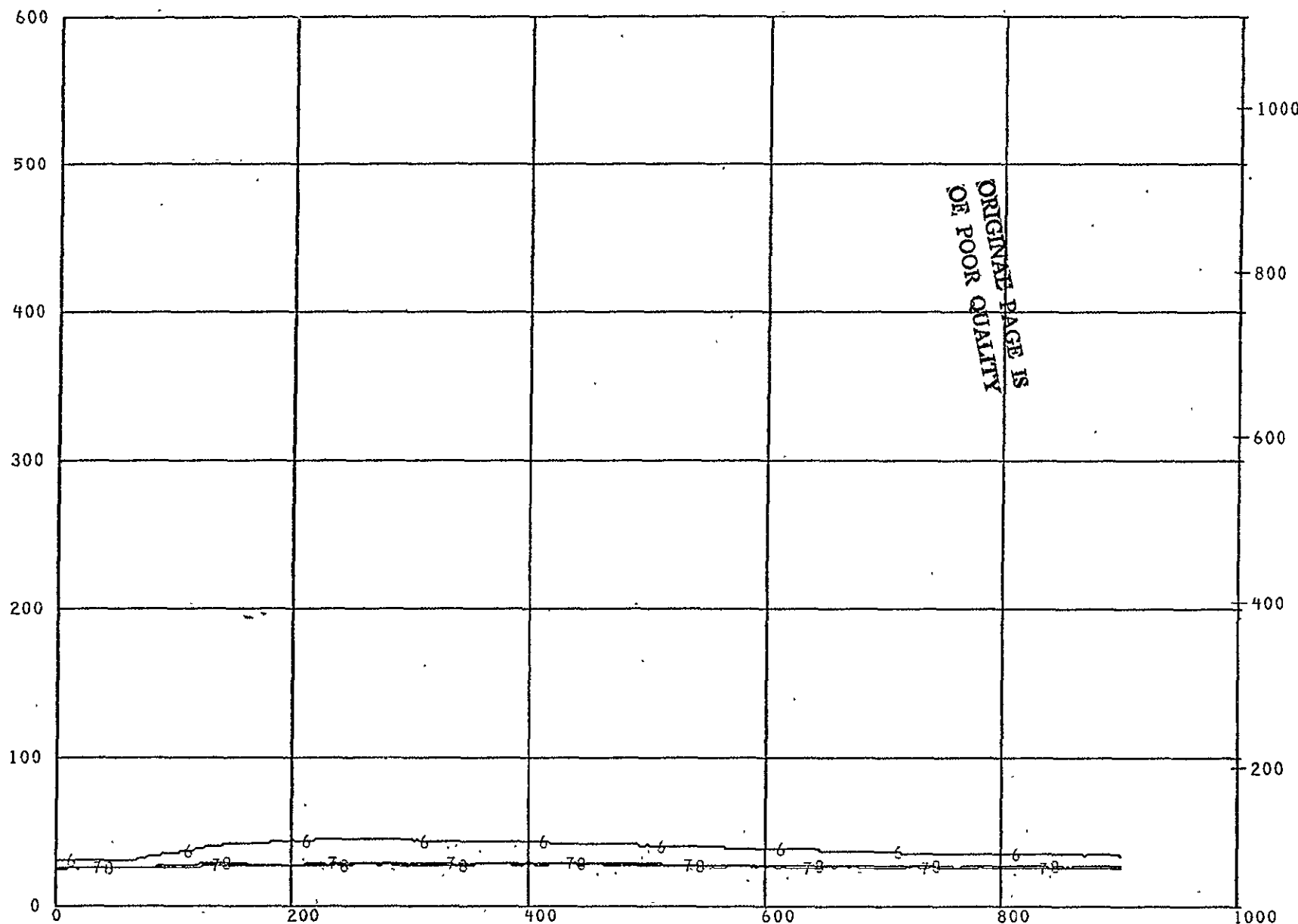
TEST ID 840288 081000

ST01

PLOT NO

4 - 1

REFERENCE TIME 15 02 00.000

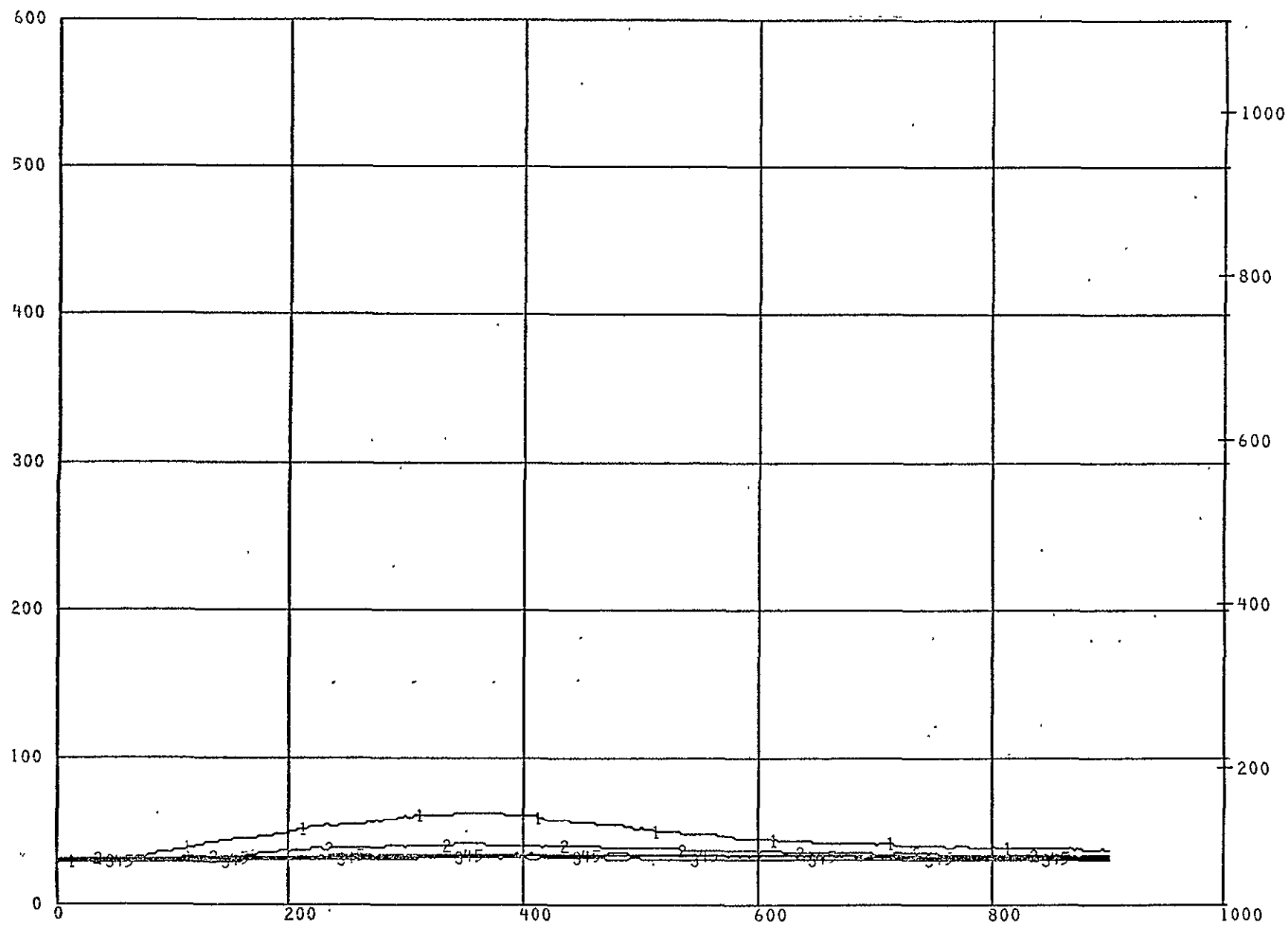
D
E
G
F

MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

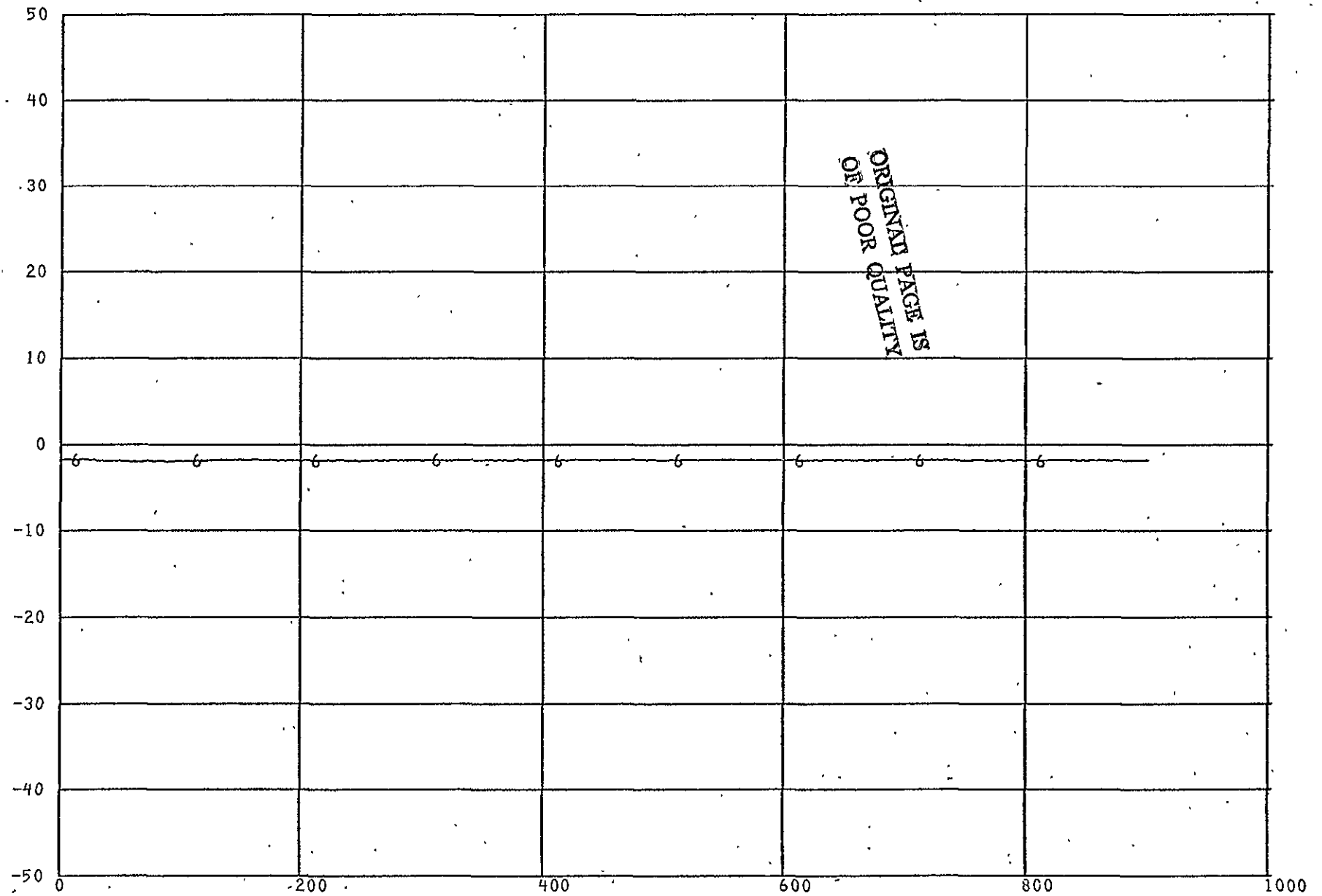
TEST ID 840288 081000

ST01

PLOT NO

6 - 1

REFERENCE TIME 15 02 00.000



MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYI
IN-H20 A6

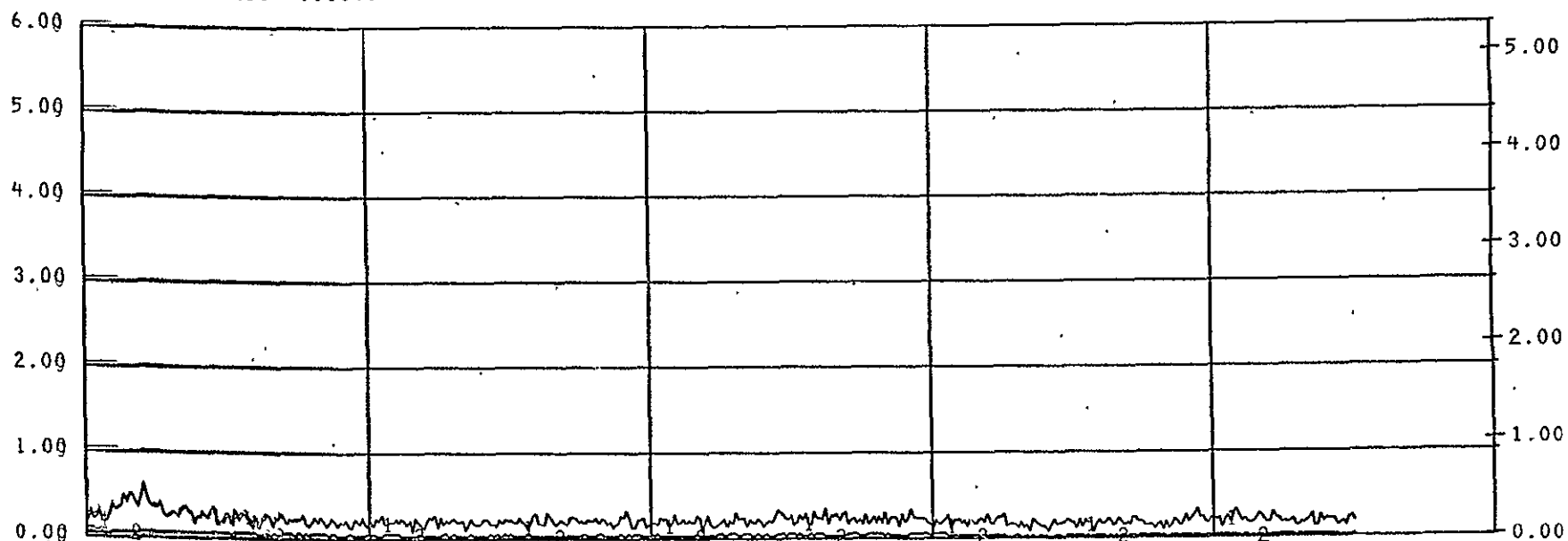
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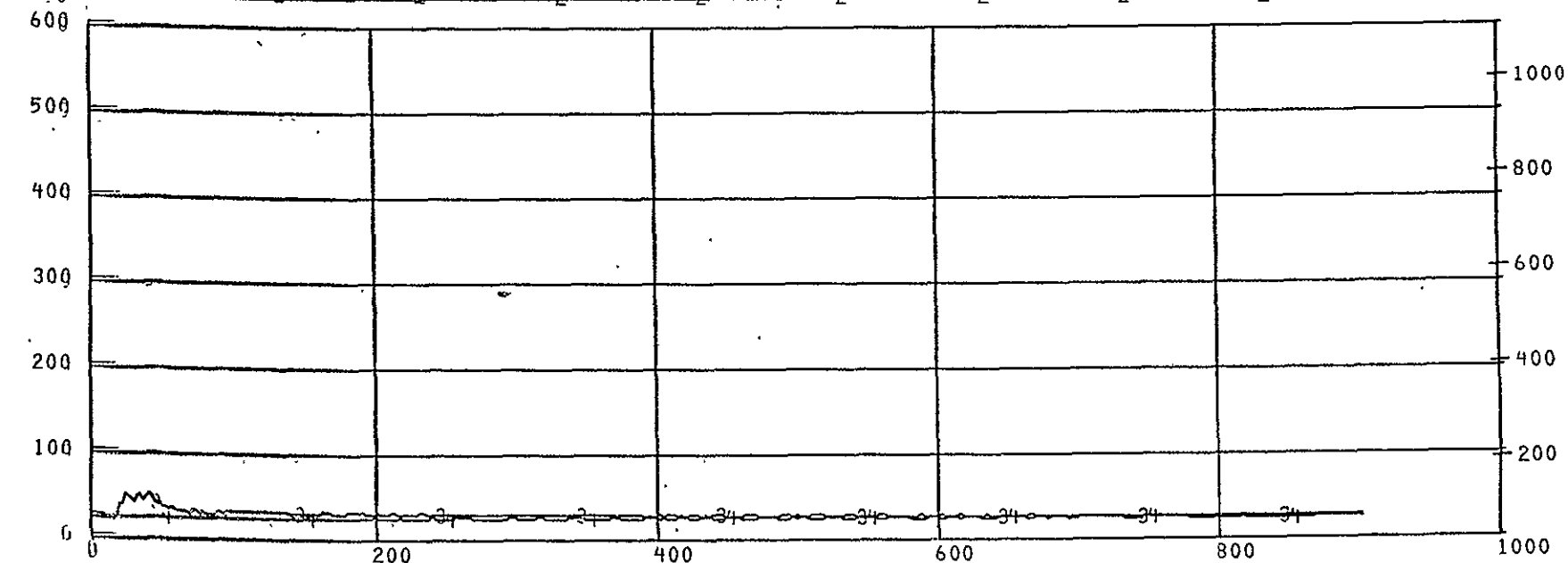
PLOT NO

1 - 1

REFERENCE TIME 08 51 00.000



BTU/F2S



DEG F

188

MEAS. NUMBER	CHANNEL ASGN.	TITLE	RANGE	UNITS	GRID-SYM
\$ C1		CALORIMETER OVER FIRE	0.00 TO 6.00	WATT/CM2	A1
\$ C2		CALORIMETER	0.00 TO 6.00	WATT/CM2	A2
\$ TC19	139		0 TO 600	DEG C	B3
\$ TC20	120		0 TO 600	DEG C	B4

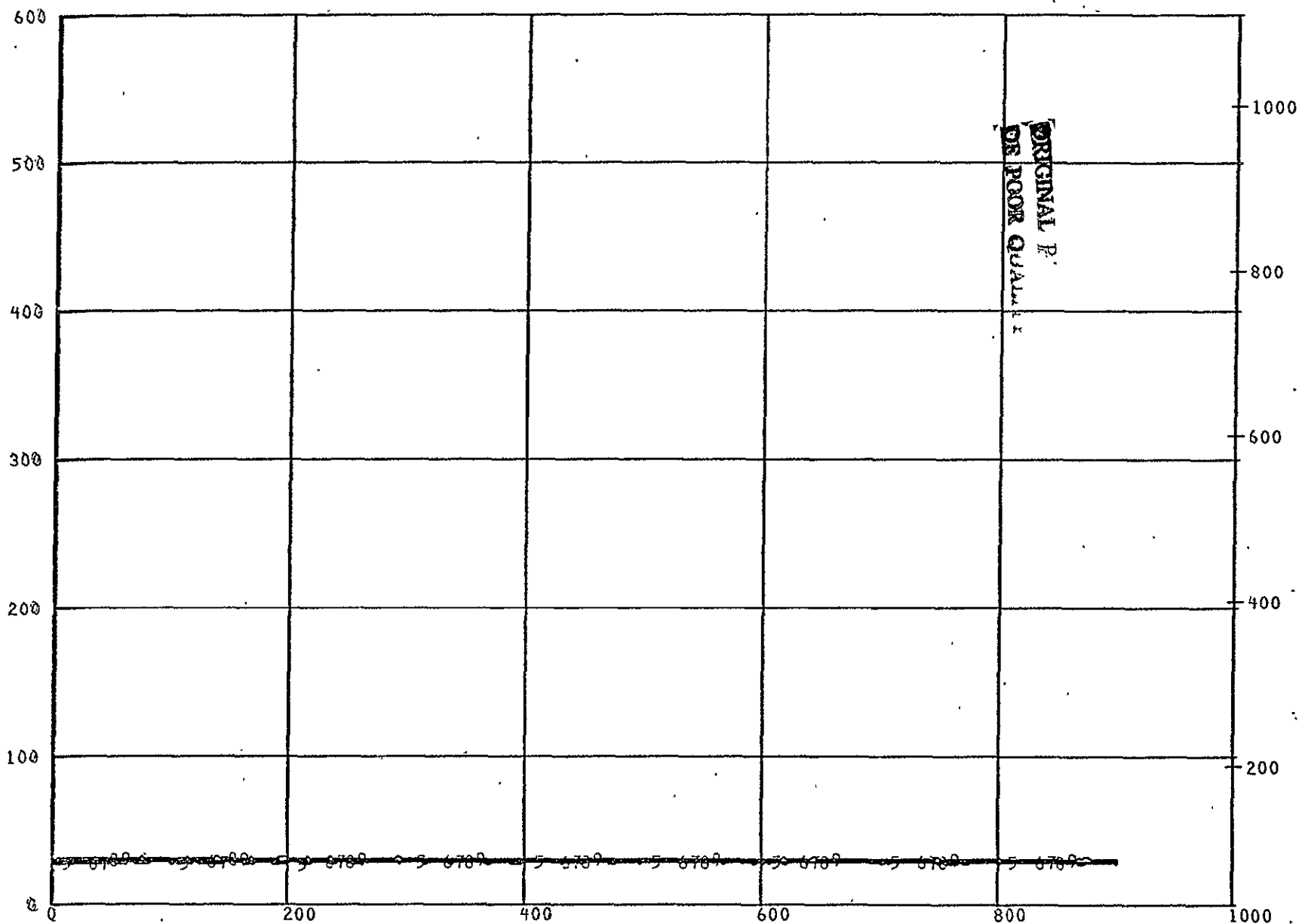
TEST ID 840288 081000

ST02

PLOT NO

2 - 1

REFERENCE TIME 08 51 00.000

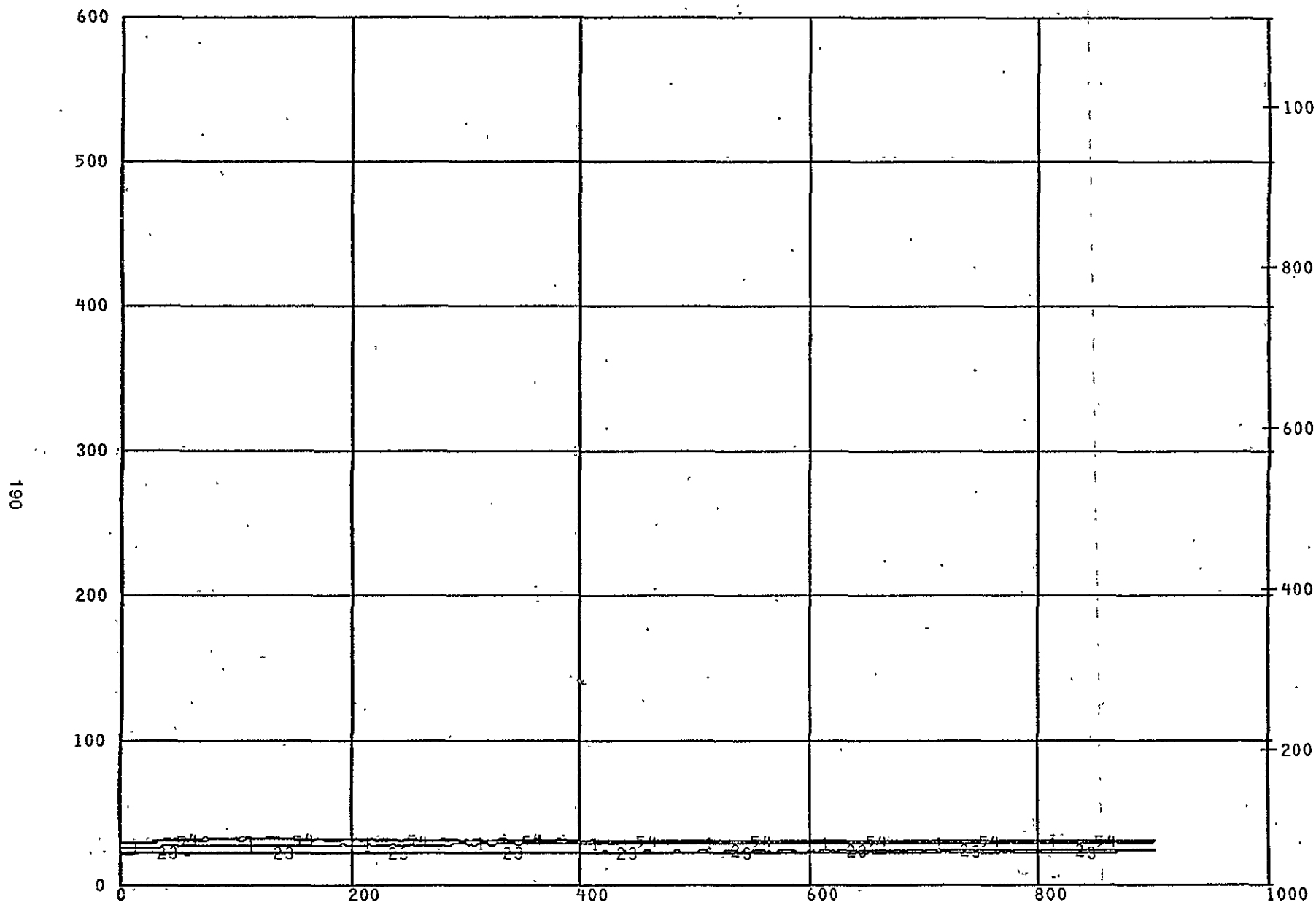


MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

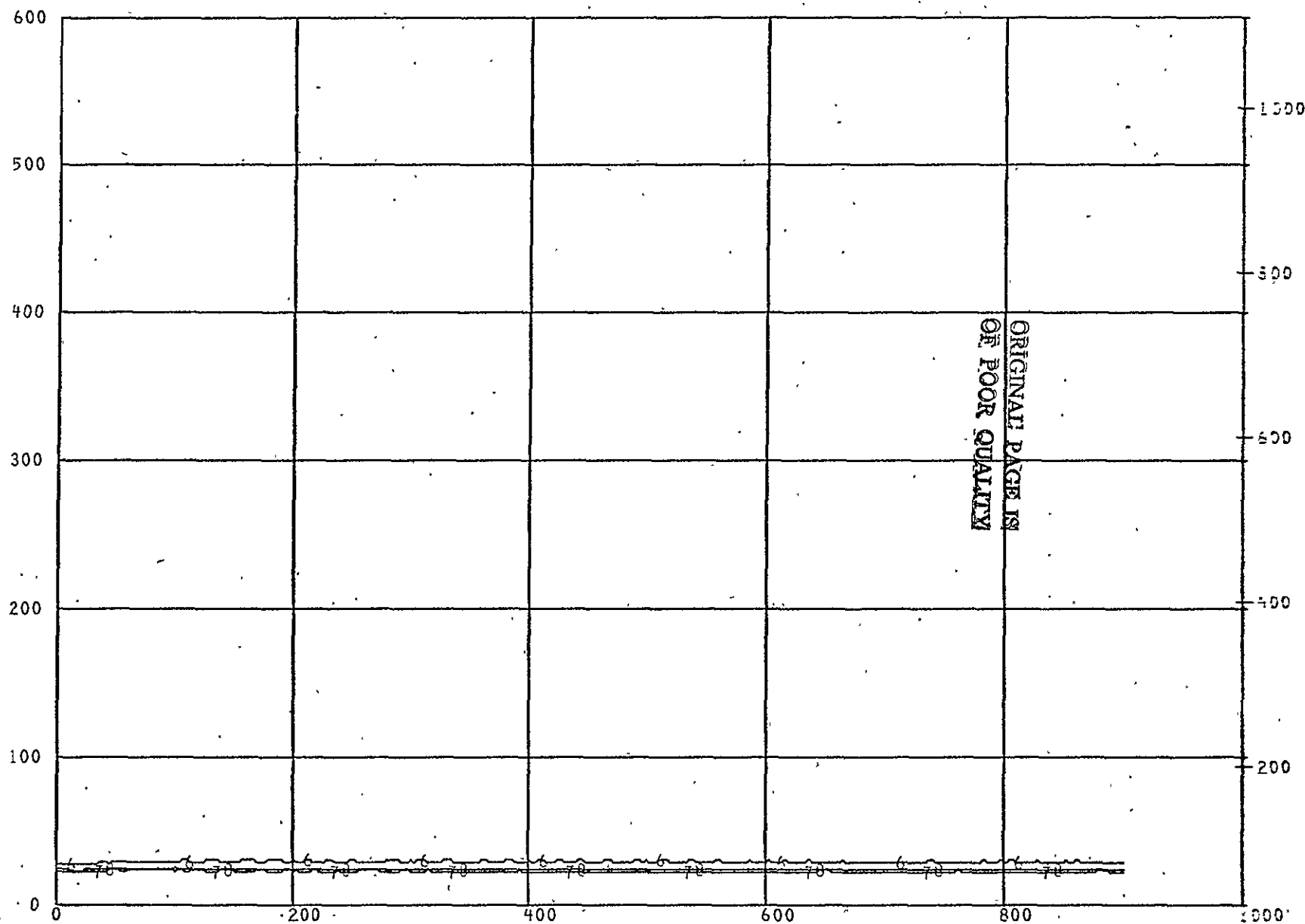
TEST ID 840288 081000

ST02

PLOT NO

4 - 1

REFERENCE TIME 08-51 00.000

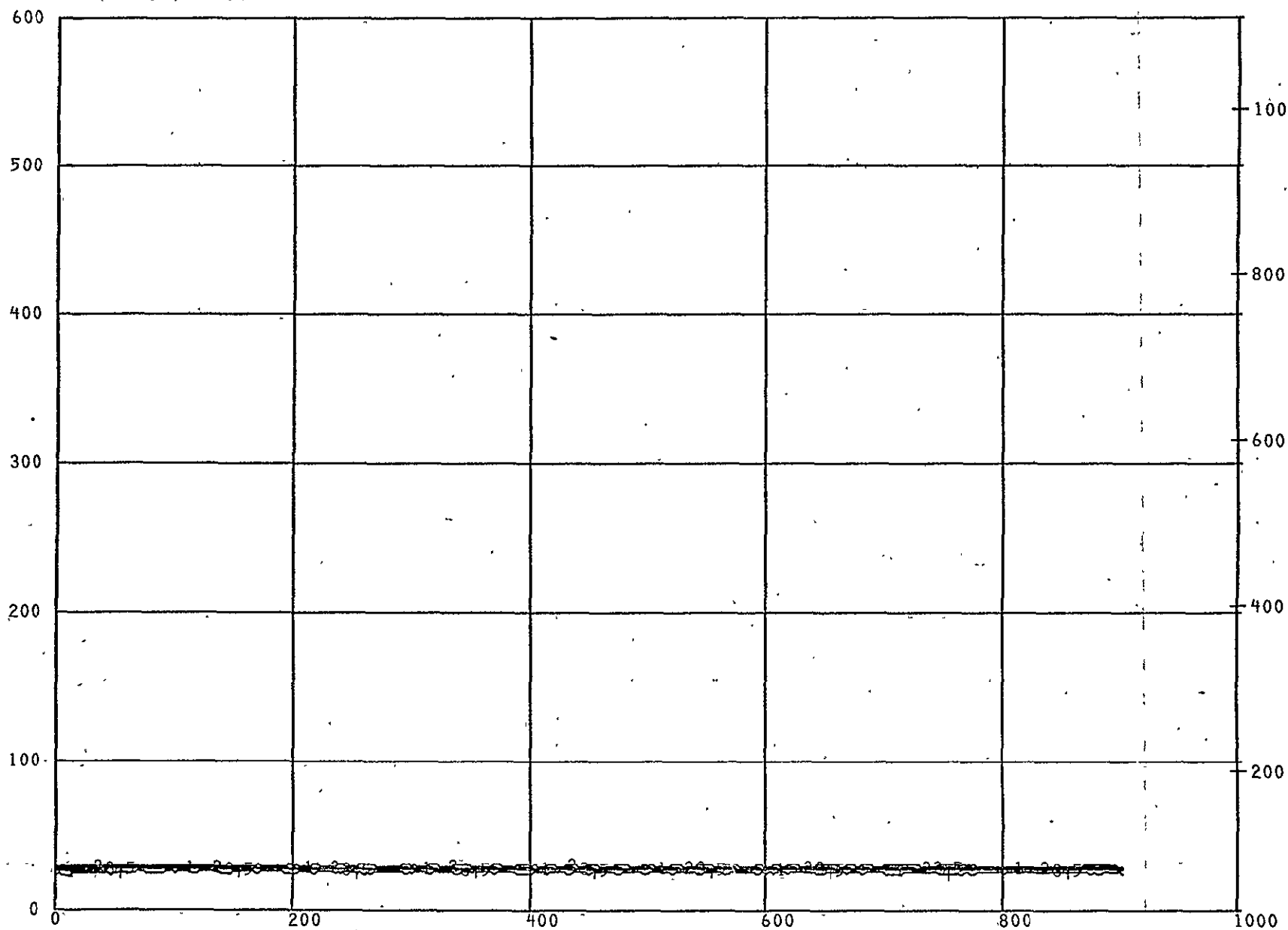
D
E
G
F

MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG	A6
DEG	A7
DEG	A8



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

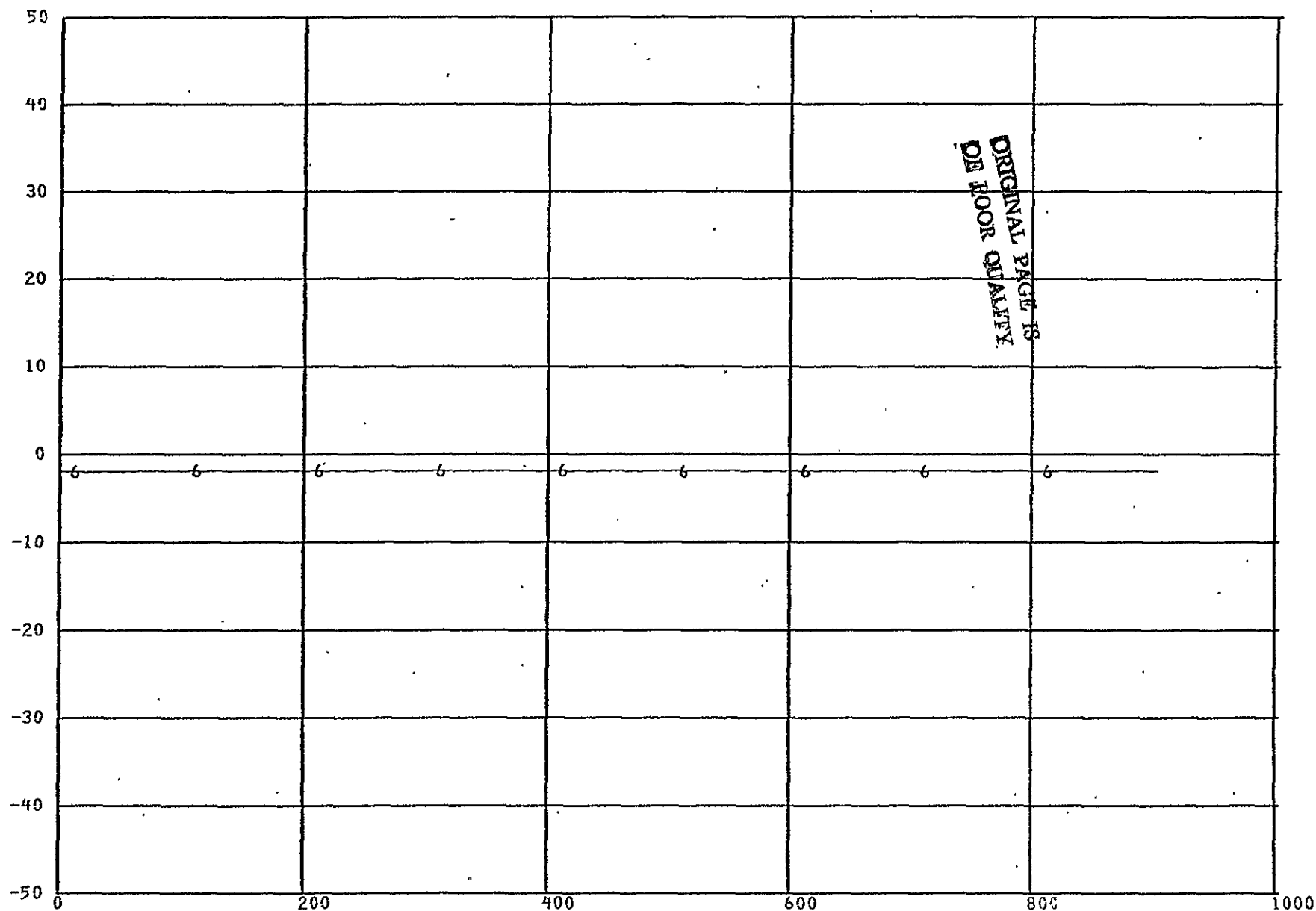
TEST ID 840288 081000

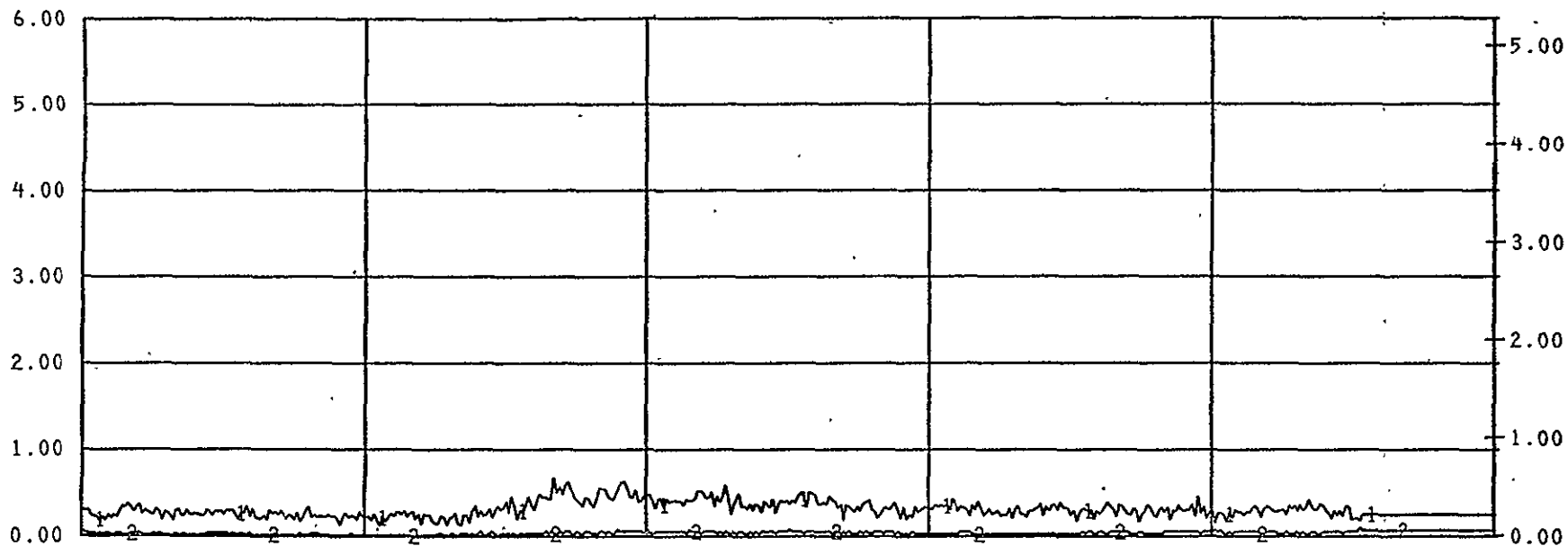
ST02

PLOT NO

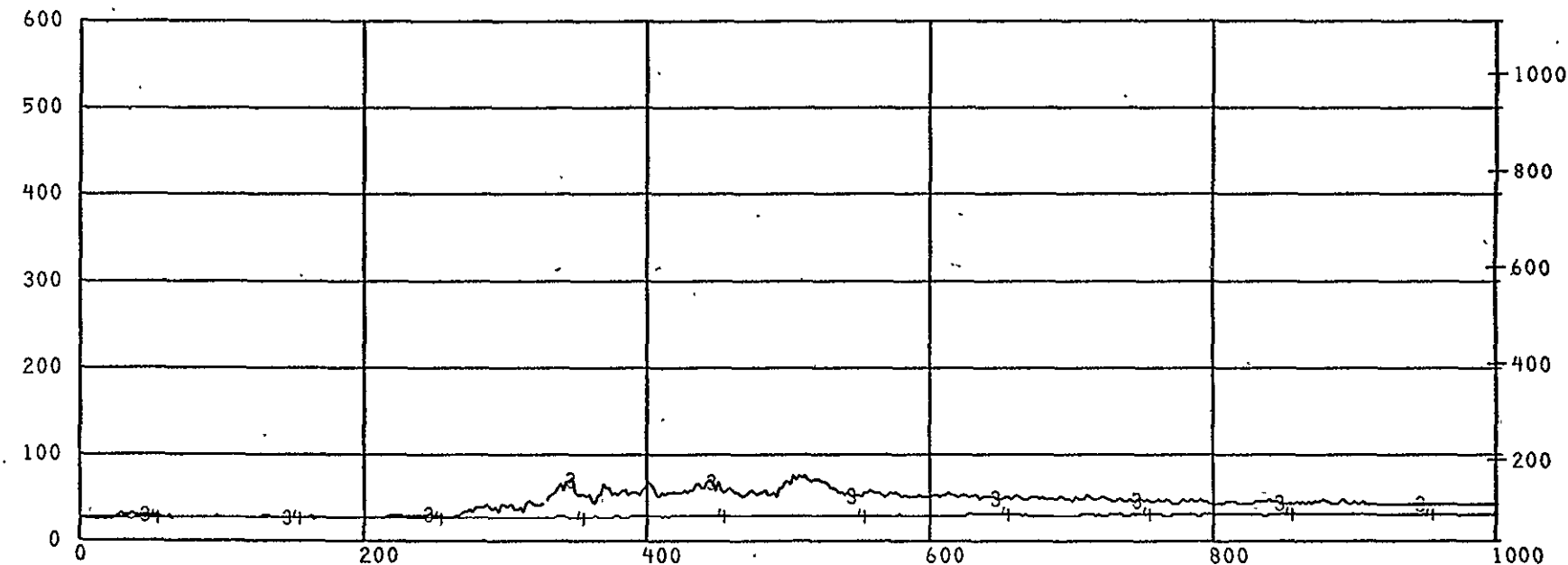
6 - 1

REFERENCE TIME 08 51 00.000





BTU/F2S



DEG F

MEAS. NUMBER	CHANNEL ASGN.	TITLE	RANGE	UNITS	GRID-SYM
\$ C1		CALORIMETER OVER FIRE	0.00 TO 6.00	WATT/CM2	A1
\$ C2		CALORIMETER	0.00 TO 6.00	WATT/CM2	A2
\$ TC19	139		0 TO 600	DEG C	B3
\$ TC20	120		0 TO 600	DEG C	B4

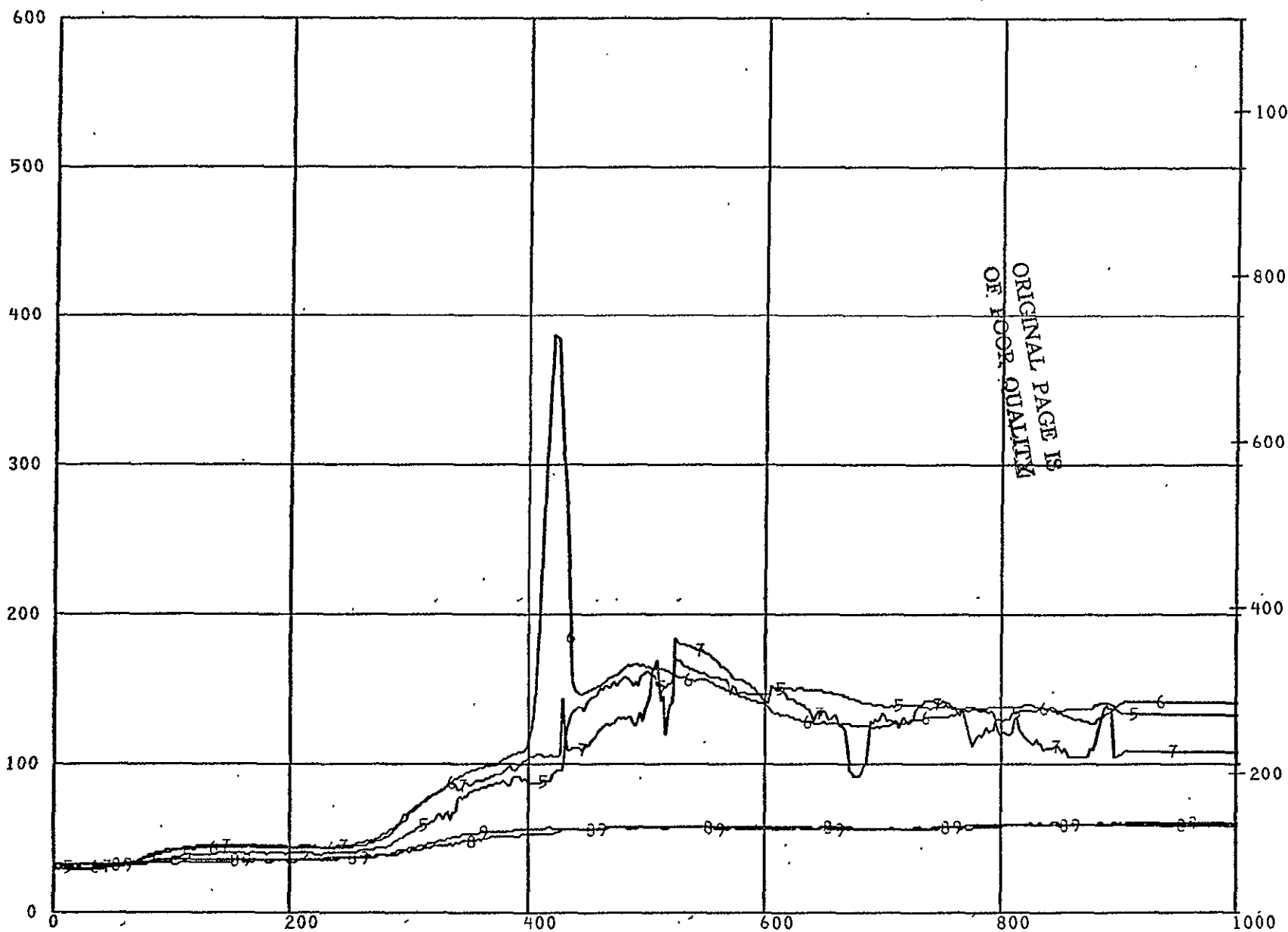
TEST ID 840288 081000

ST04

PLOT NO

2 - 1

REFERENCE TIME 10 25 00.000



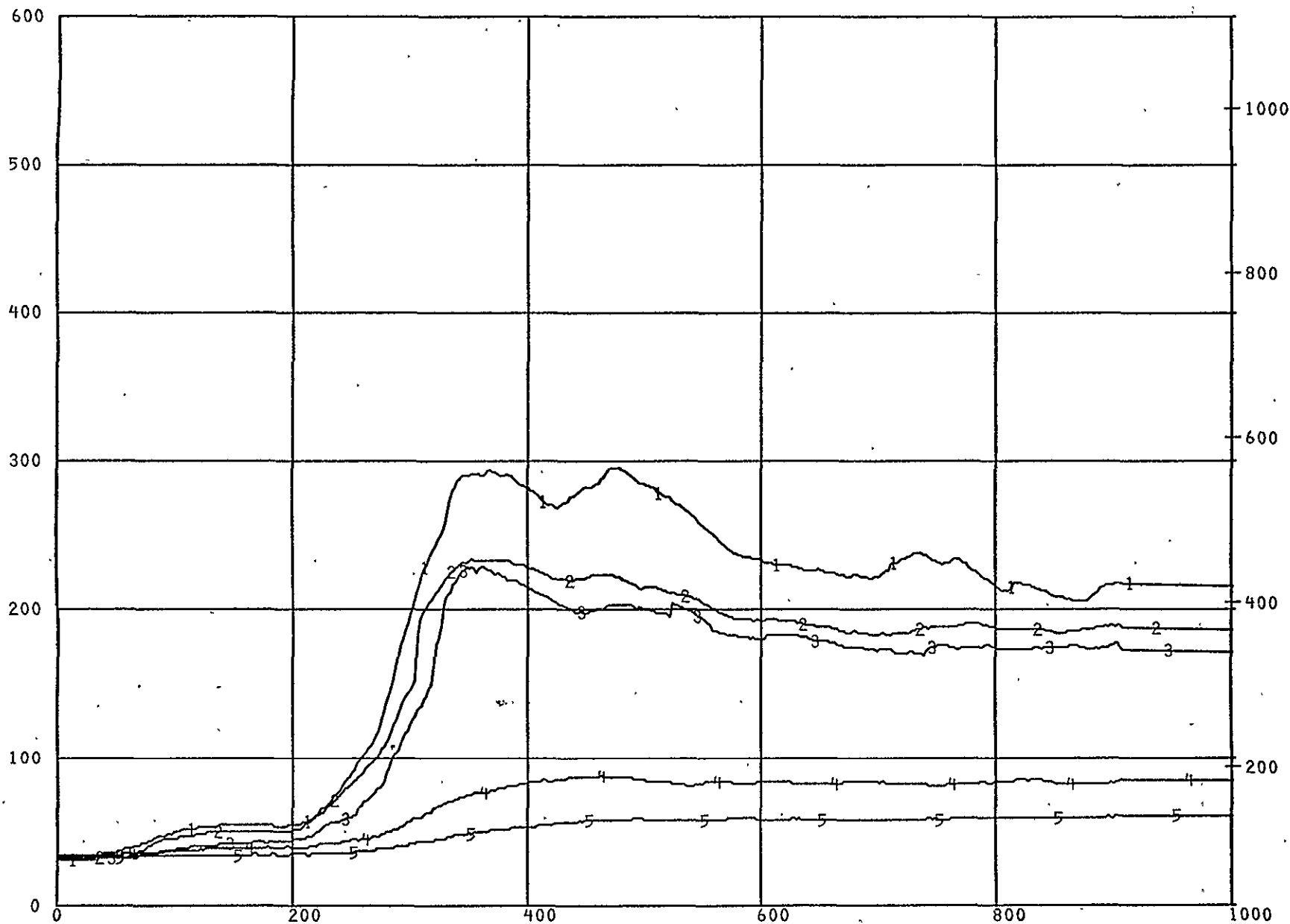
MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

196



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

TITLE
RELATIVE TIME IN SEC

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 081000

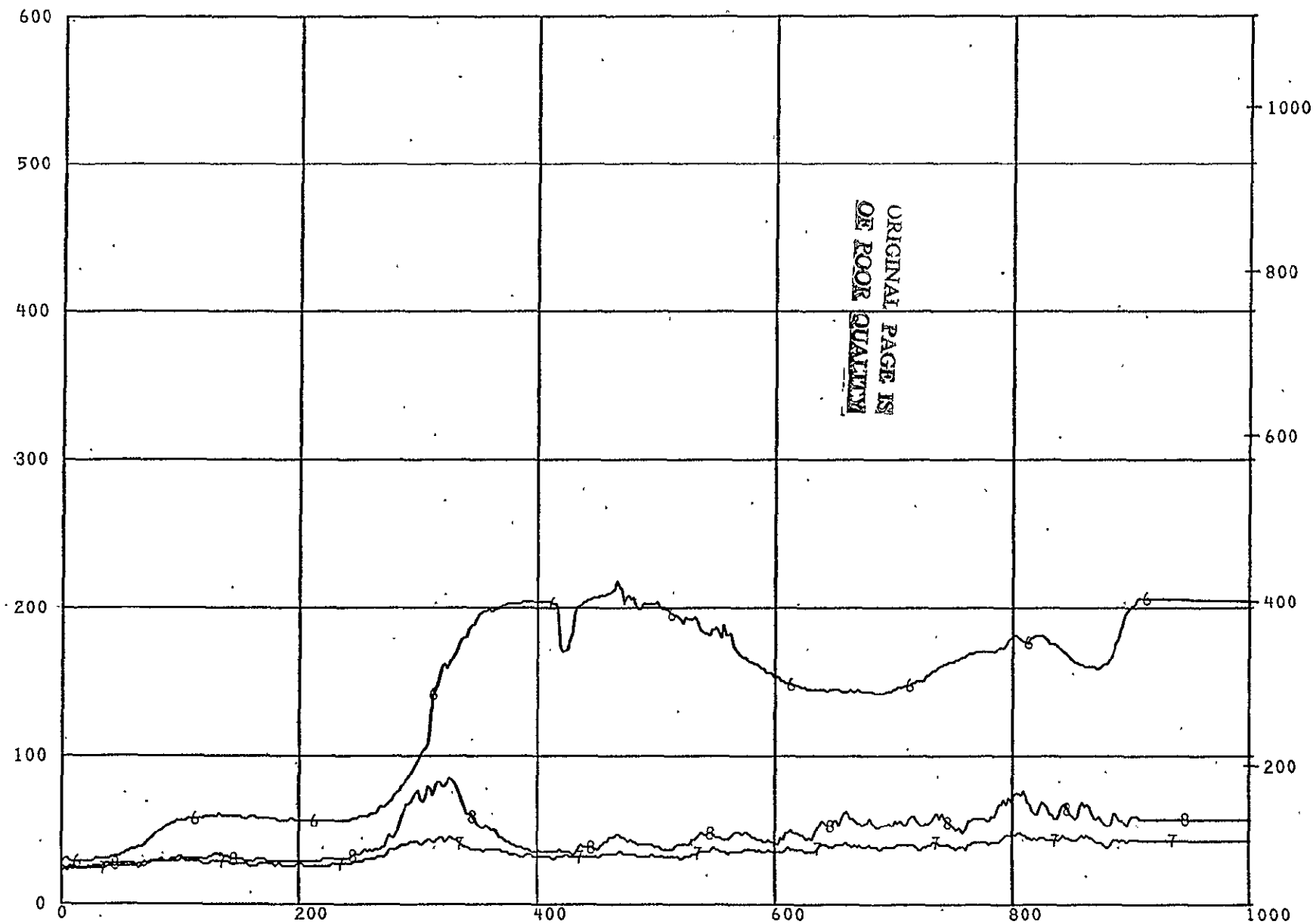
ST04

PLOT NO 4 - 1

REFERENCE TIME 10 25 00.000

D
E
G
F

197

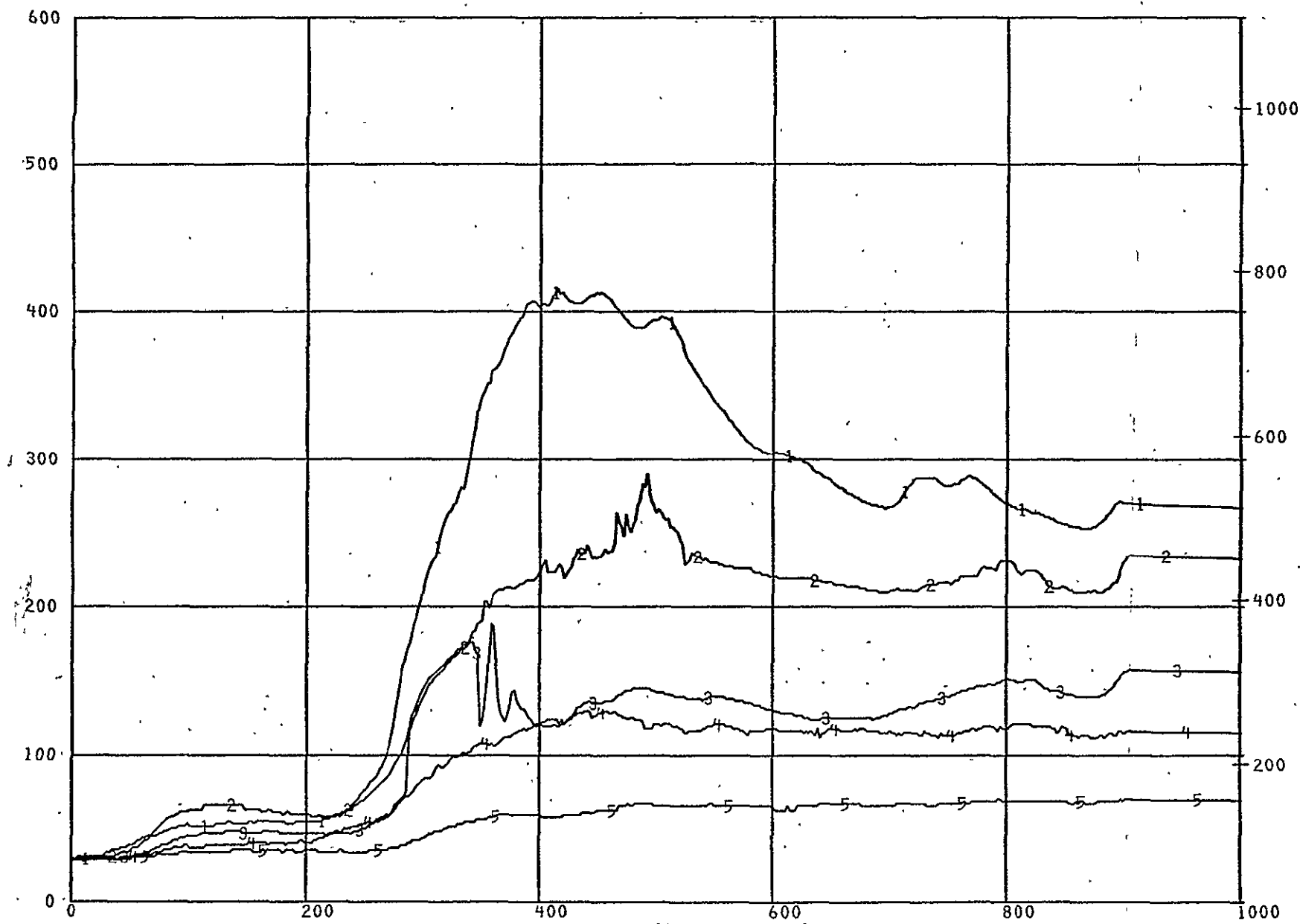


MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

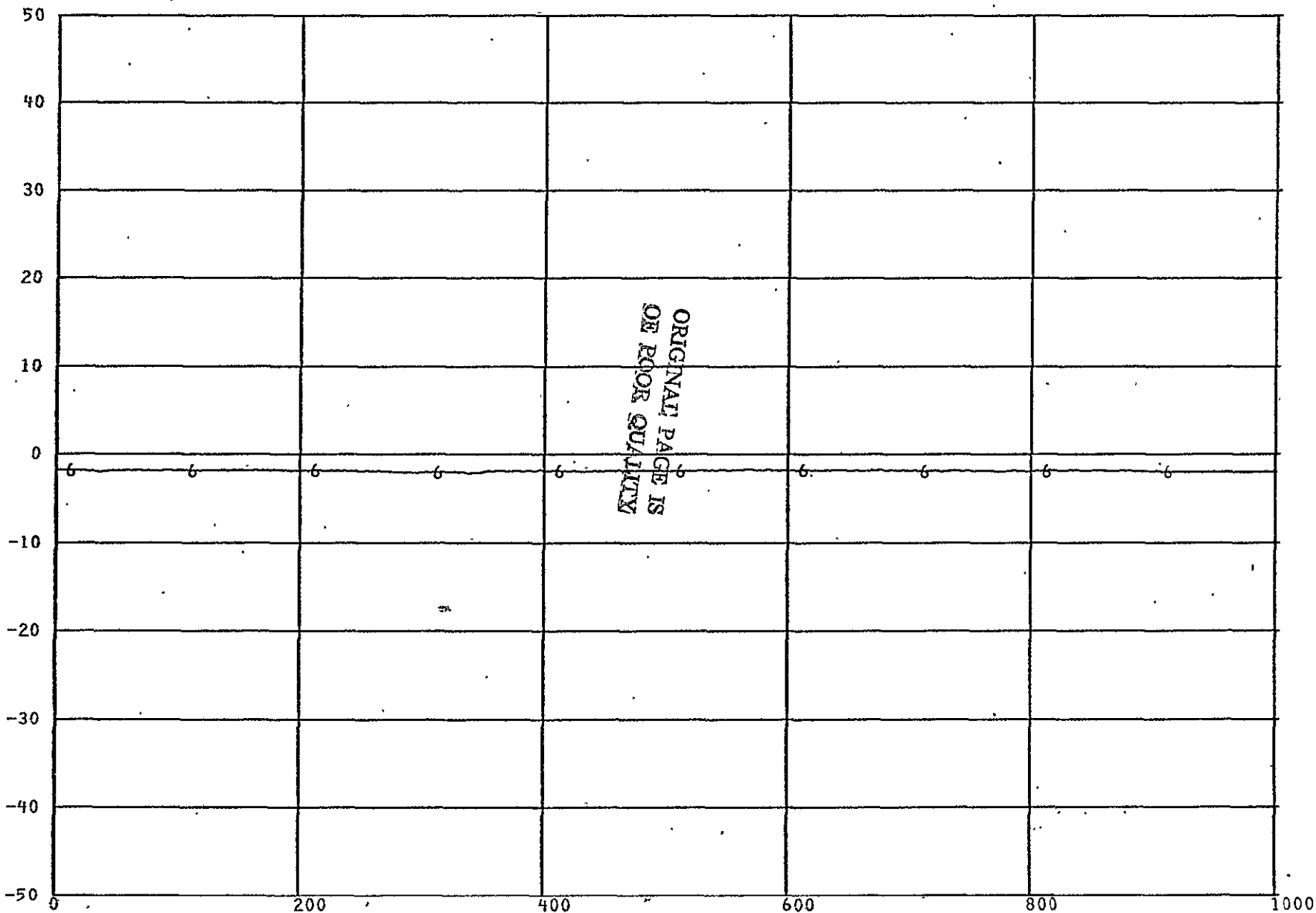
TEST ID 840288 081000

ST04

PLOT NO

6 - 1

REFERENCE TIME 10 25 00.000



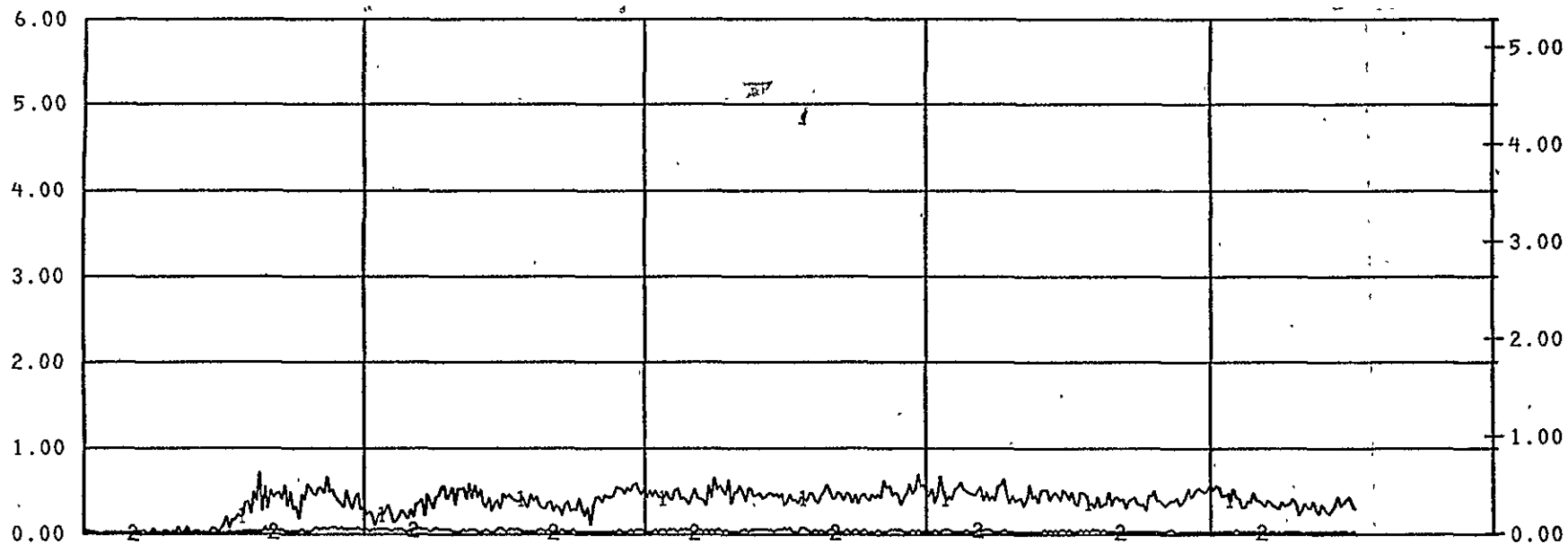
MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

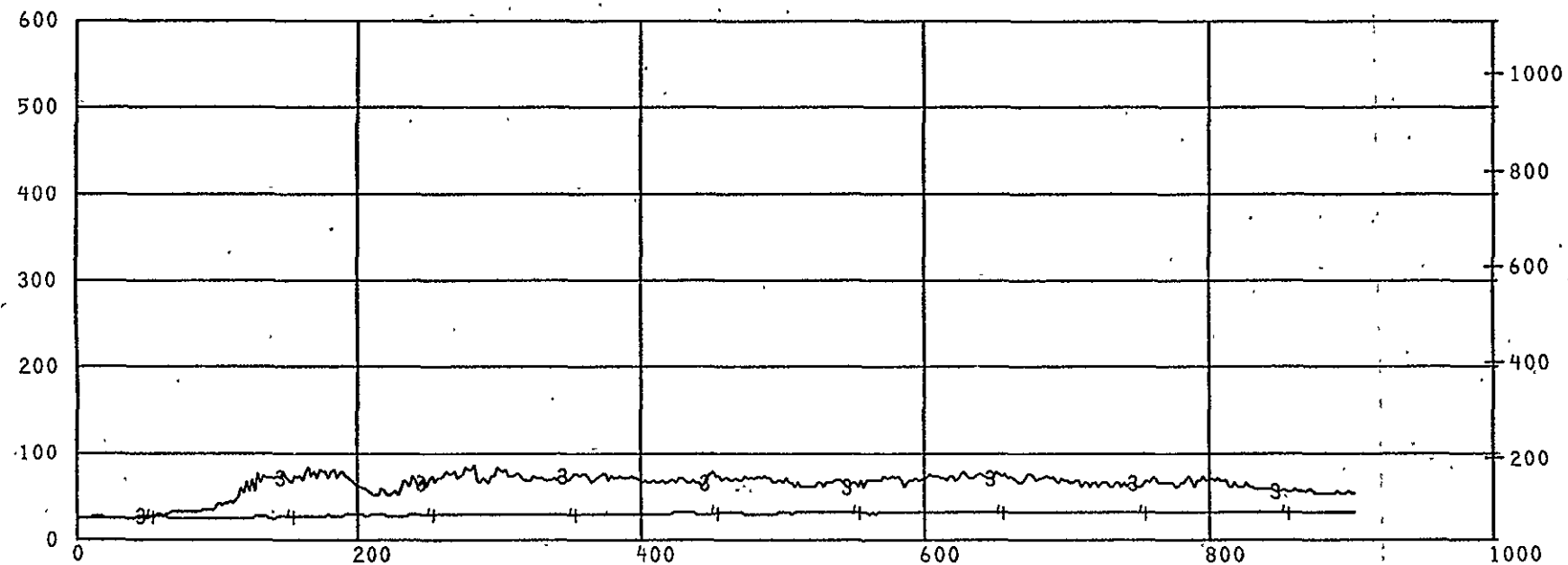
TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
IN-H20 A6

B
T
U
/
F
2
S

200

D
E
G
F

MEAS. NUMBER	CHANNEL ASGN.
\$ C1	
\$ C2	
\$ TC19	139
\$ TC20	120

TITLE
CALORIMETER OVER FIRE
CALORIMETER

RANGE
0.00 TO 6.00
0.00 TO 6.00
0 TO 600
0 TO 600

UNITS	GRID-SYM
WATT/CM2	A1
WATT/CM2	A2
DEG C	B3
DEG C	B4

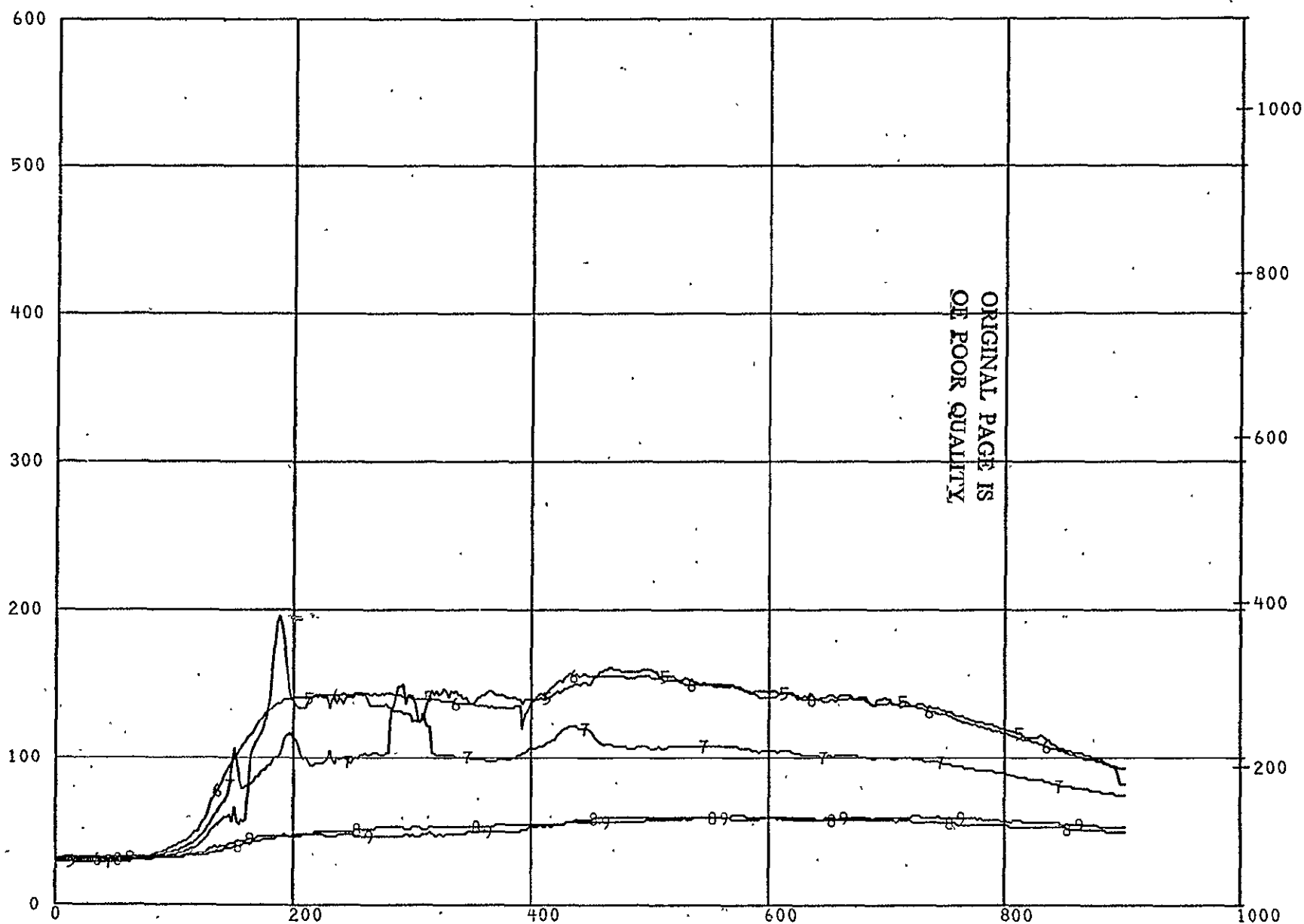
TEST ID 840288 081000

ST05

PLOT NO

2 - 1

REFERENCE TIME 13 17 00.000



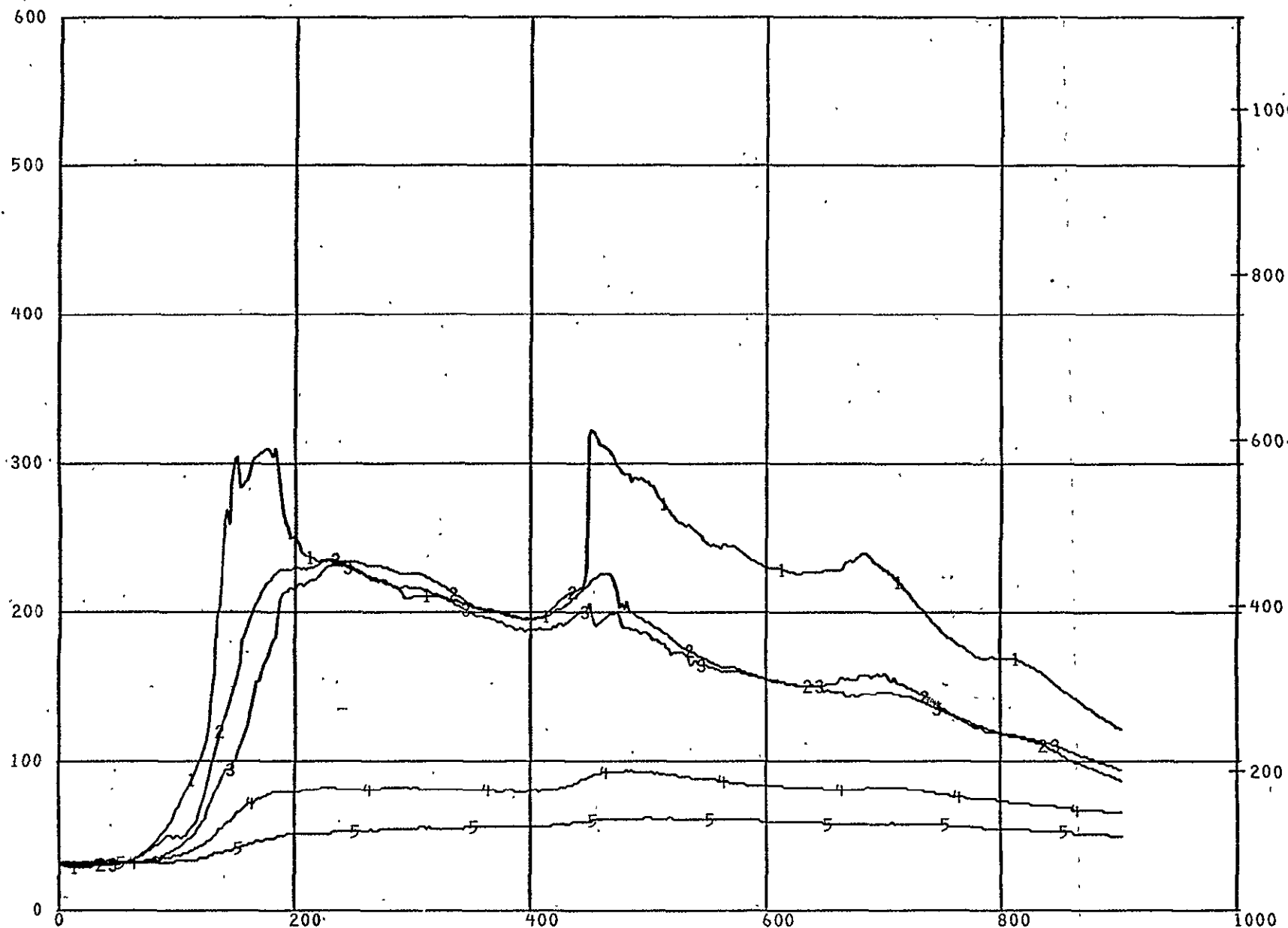
MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

202



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 081000

ST05

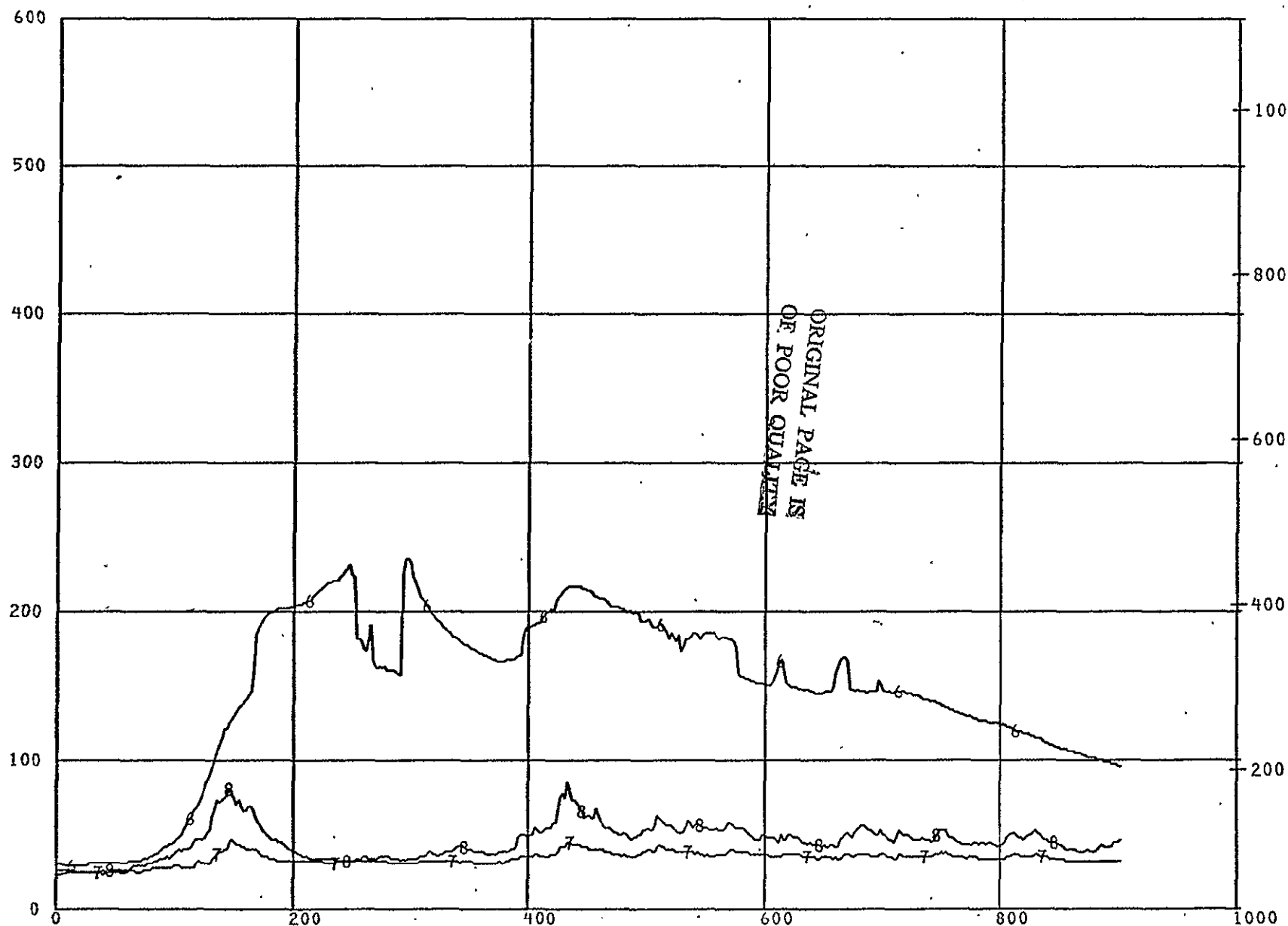
PLOT NO

4 - 1

REFERENCE TIME 13 17 00.000

D
E
G
F

203



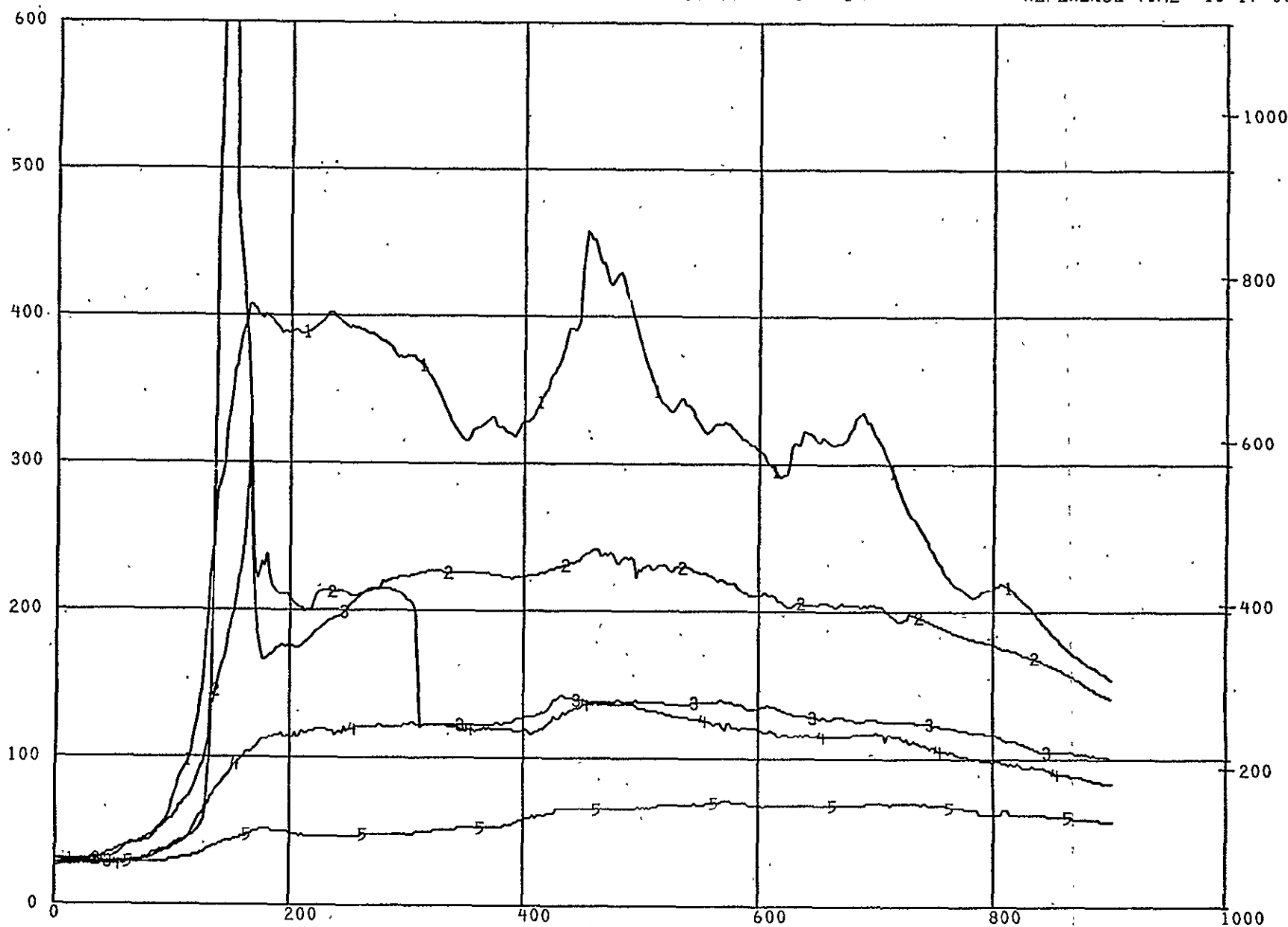
MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

204



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

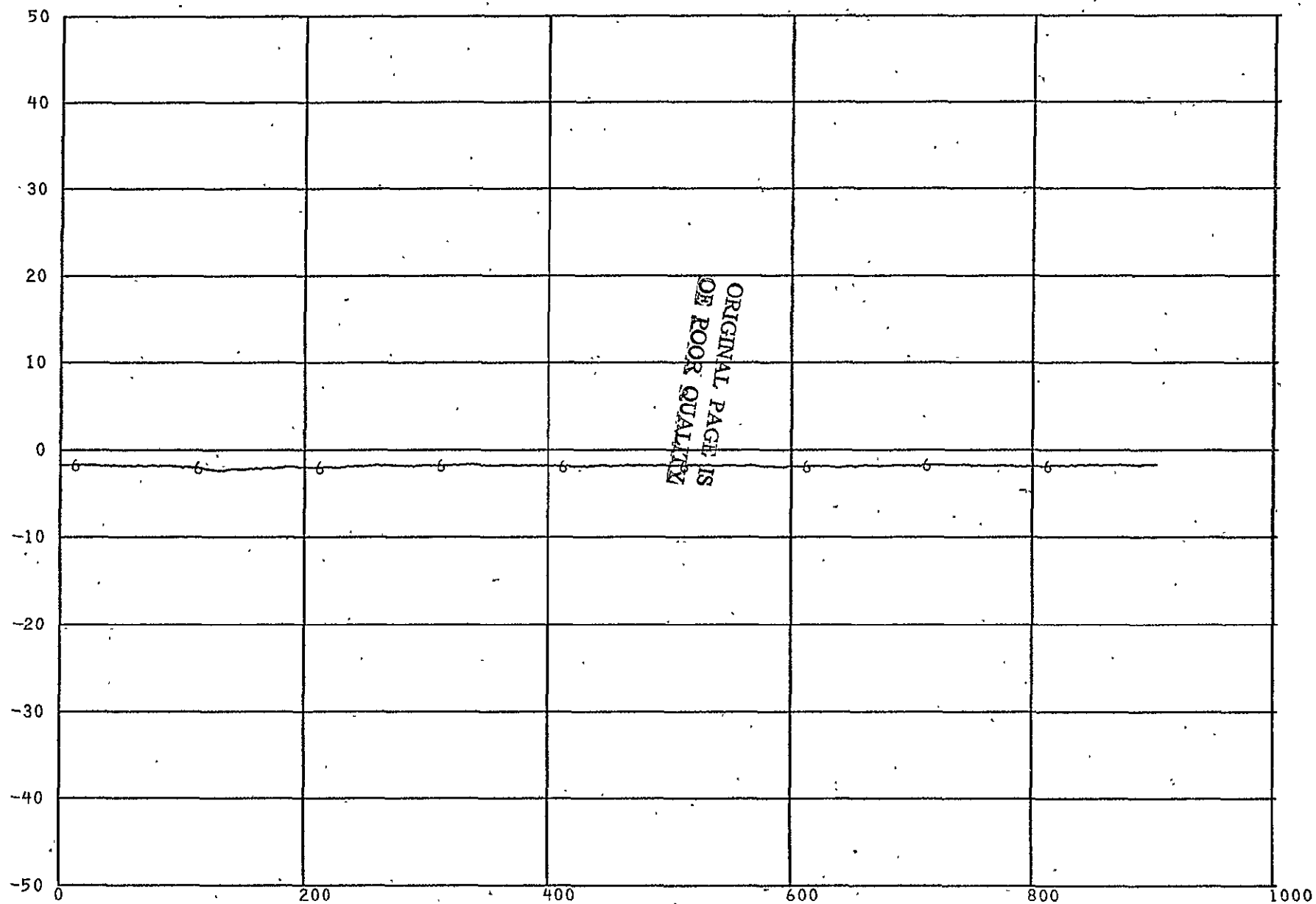
UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 081000

ST05

PLOT NO 6 - 1

REFERENCE TIME 13 17 00.000



MEAS. NUMBER
PRESS

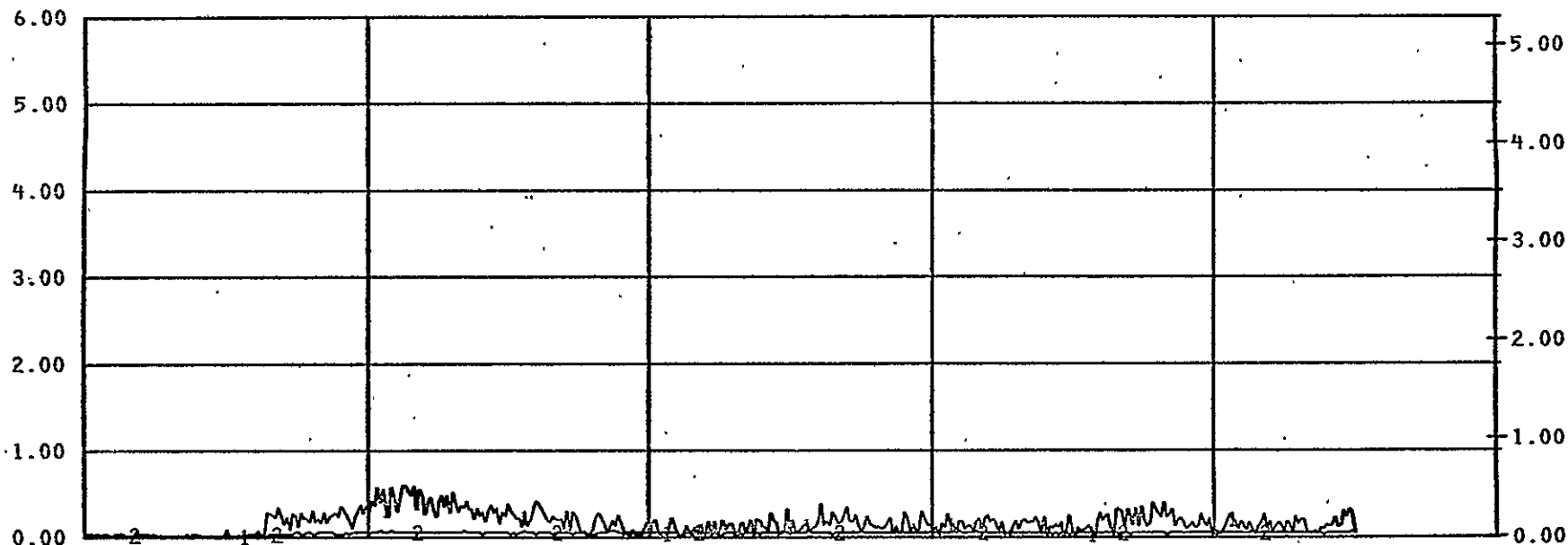
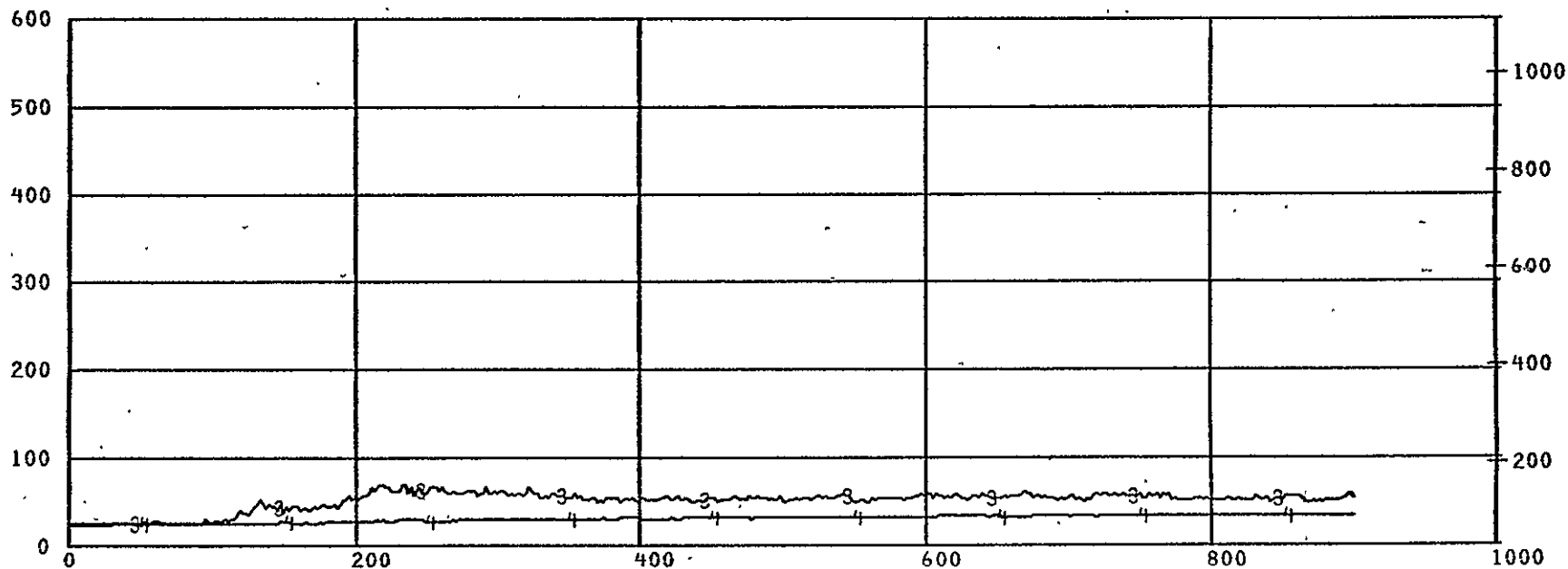
CHANNEL ASGN.
098

RELATIVE TIME IN SEC
TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
1N-H20 A6

206

B
T
U
/
F
2
SD
E
G
F

MEAS. NUMBER	CHANNEL ASGN.
\$ C1	
\$ C2	
\$ TC19	139
\$ TC20	120

RELATIVE TIME IN SEC

TITLE

CALORIMETER OVER FIRE

CALORIMETER

RANGE

0.00 TO 6.00

0.00 TO 6.00

0 TO 600

0 TO 600

UNITS	GRID-SYM
WATT/CM2	A1
WATT/CM2	A2
DEG C	B3
DEG C	B4

TEST ID 840288 081000

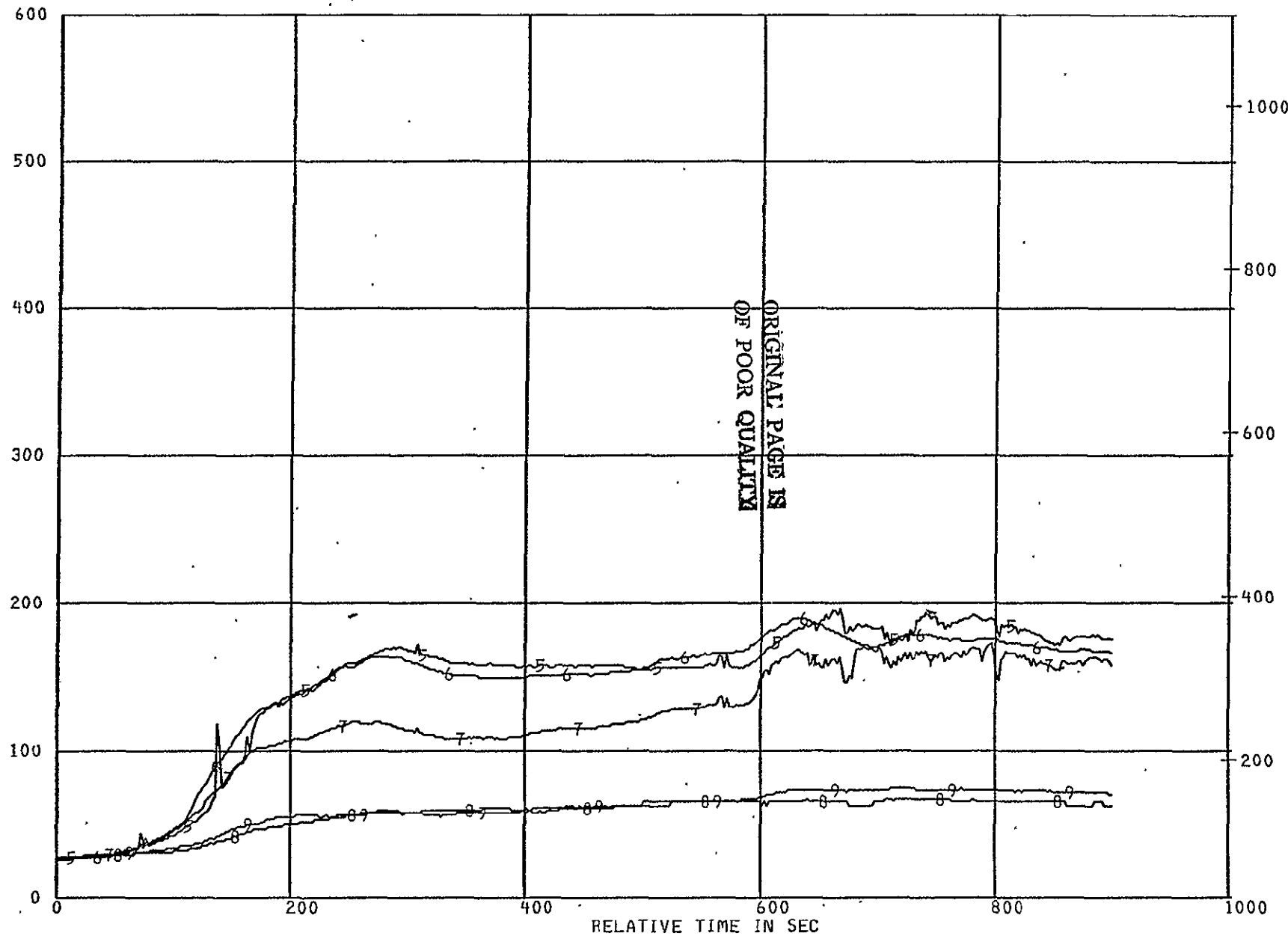
ST06

PLOT NO 2 ~ 1

REFERENCE TIME 13 57 00.000

D
E
G
F

207



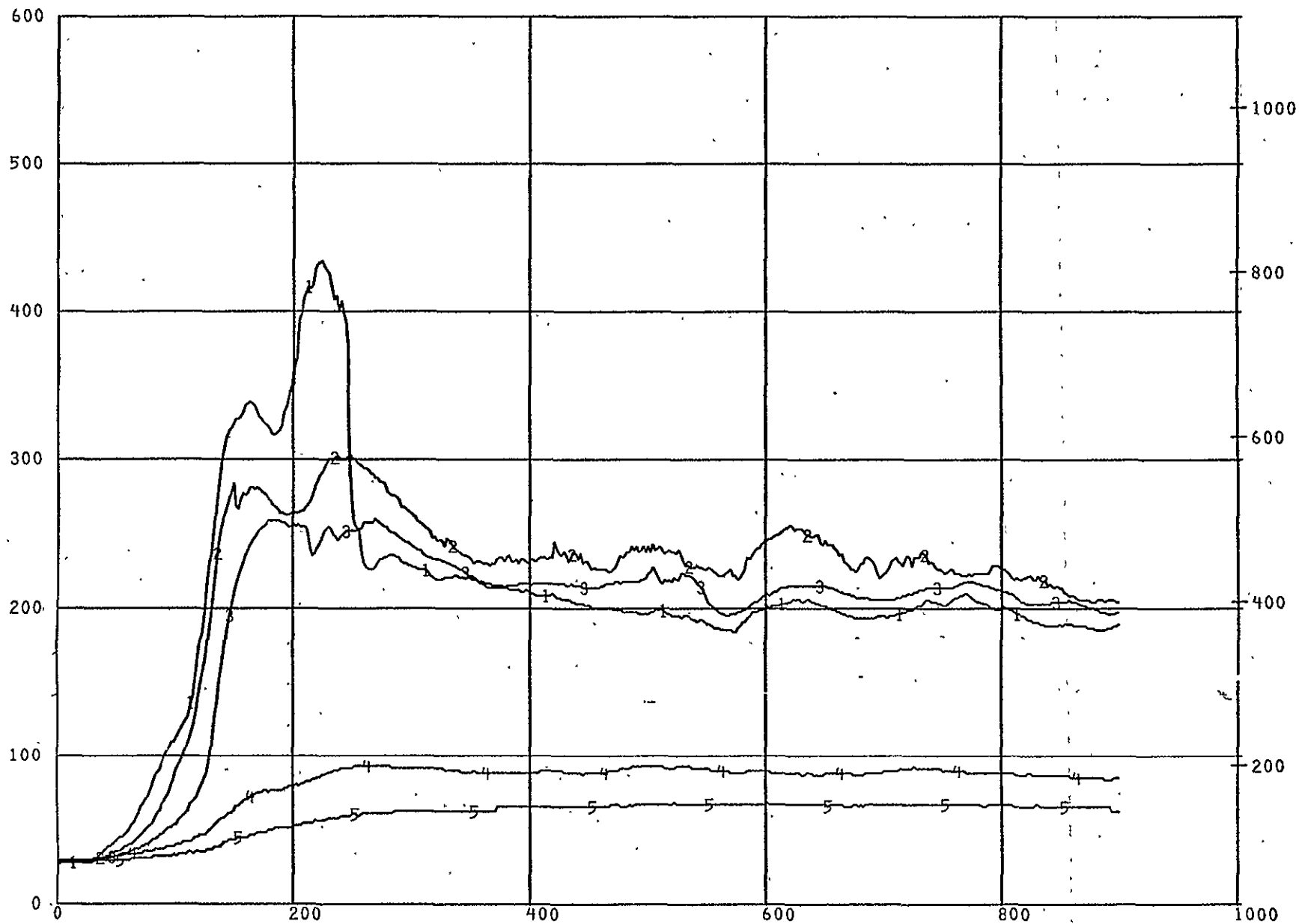
MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

208



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

TITLE
RELATIVE TIME IN SEC

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 081000

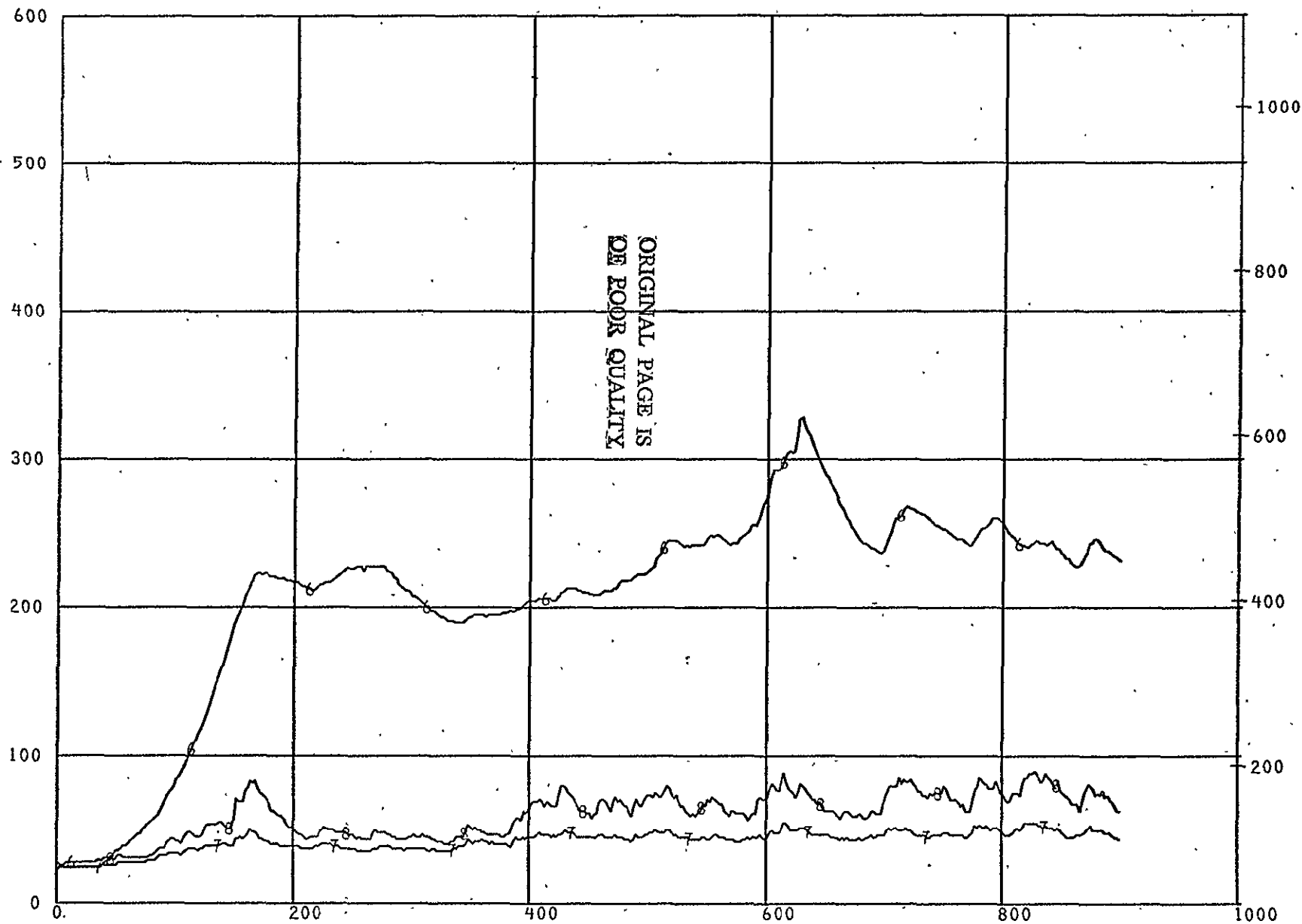
ST06

PLOT NO

4 - 1

REFERENCE TIME 13 57 00.000

209



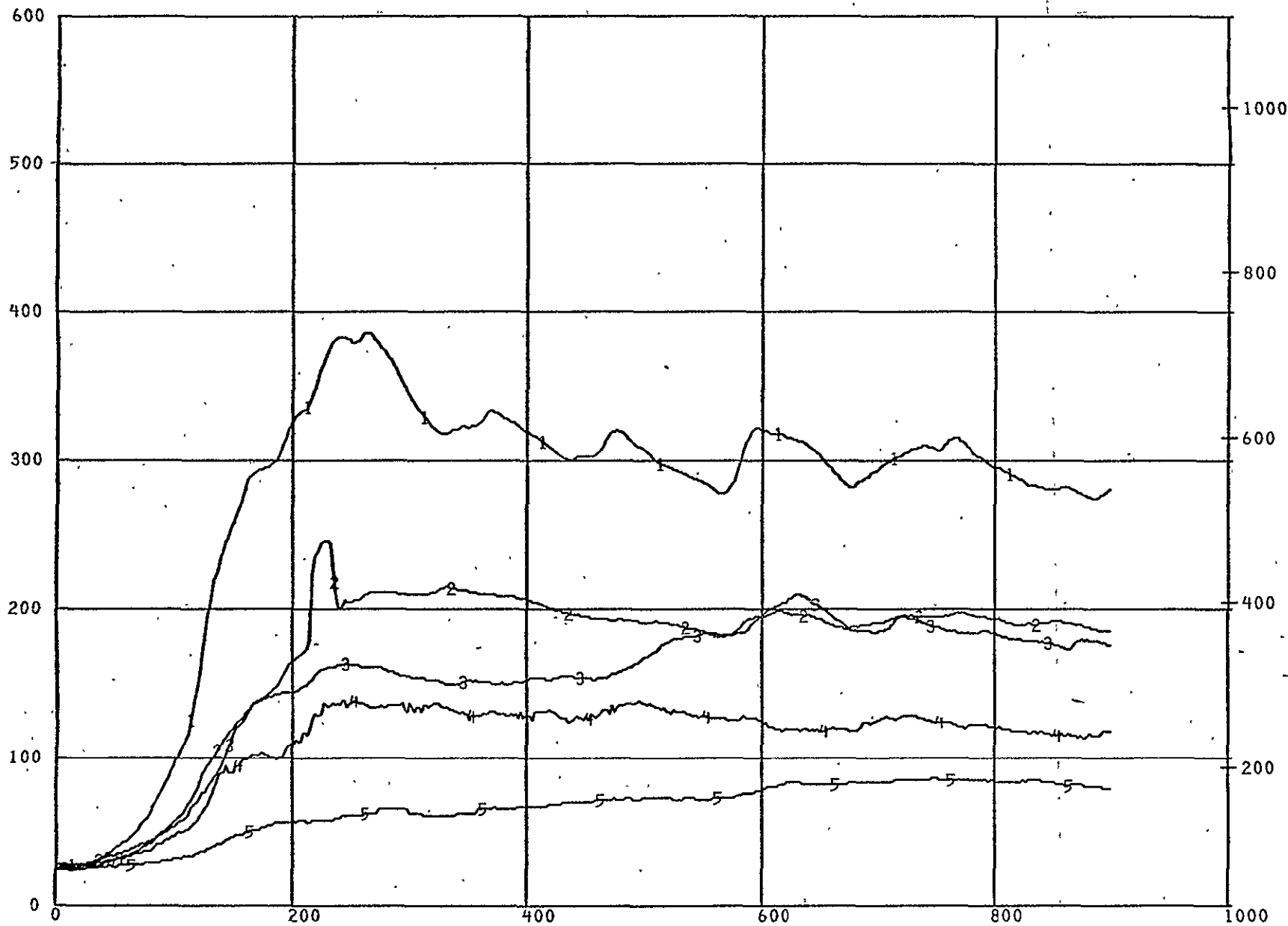
MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

RELATIVE TIME IN. SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

210



MEAS. NUMBER	CHANNEL ASGN.	TITLE	RANGE	UNITS	GRID-SYM
\$ TC14	134		0 TO 600	DEG C	A1
\$ TC15	135		0 TO 600	DEG C	A2
\$ TC16	136		0 TO 600	DEG C	A3
\$ TC17	137		0 TO 600	DEG C	A4
\$ TC18	138		0 TO 600	DEG C	A5

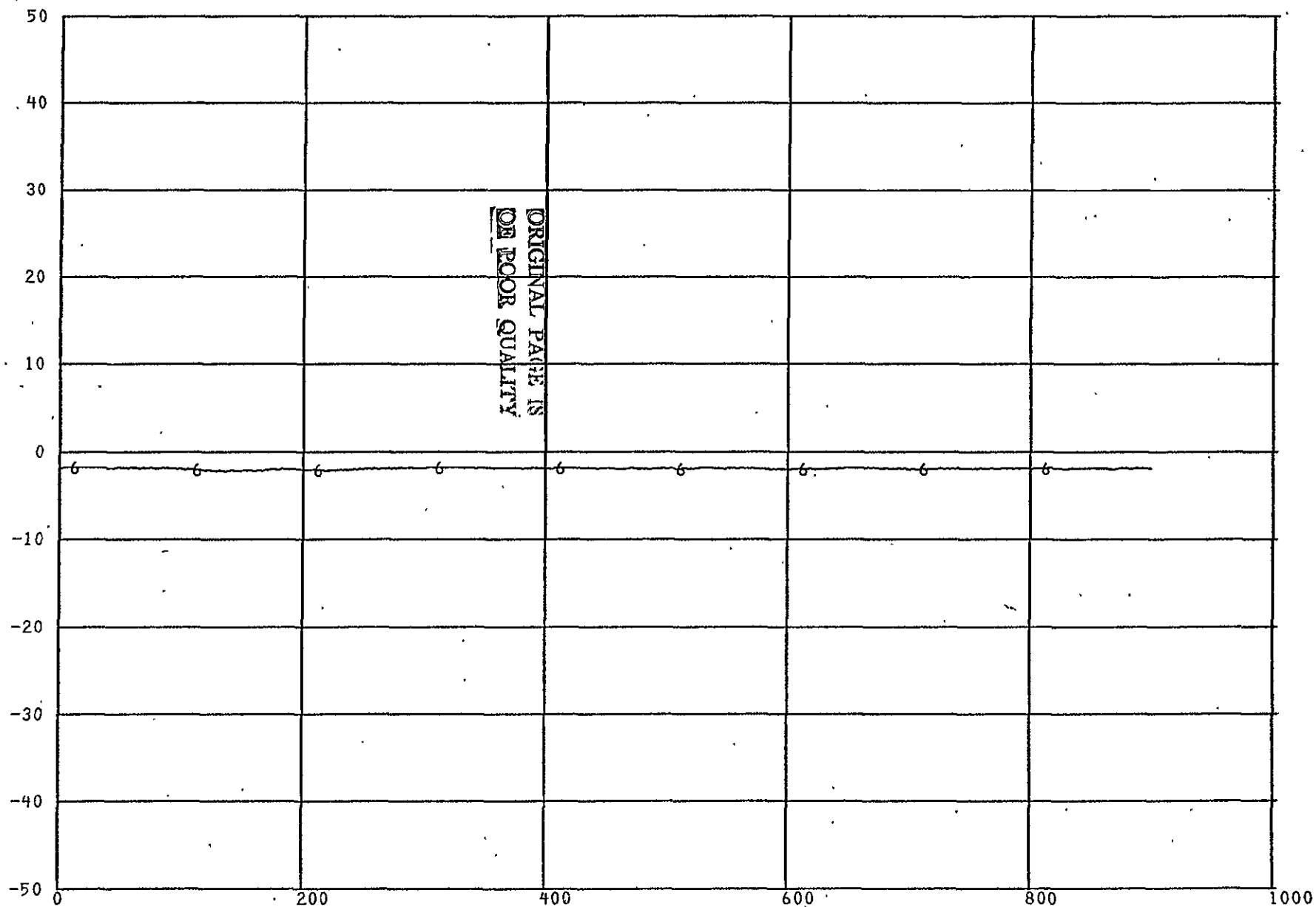
TEST ID 840288 081000

ST06

PLOT NO

6 - 1

REFERENCE TIME 13 57 00.000



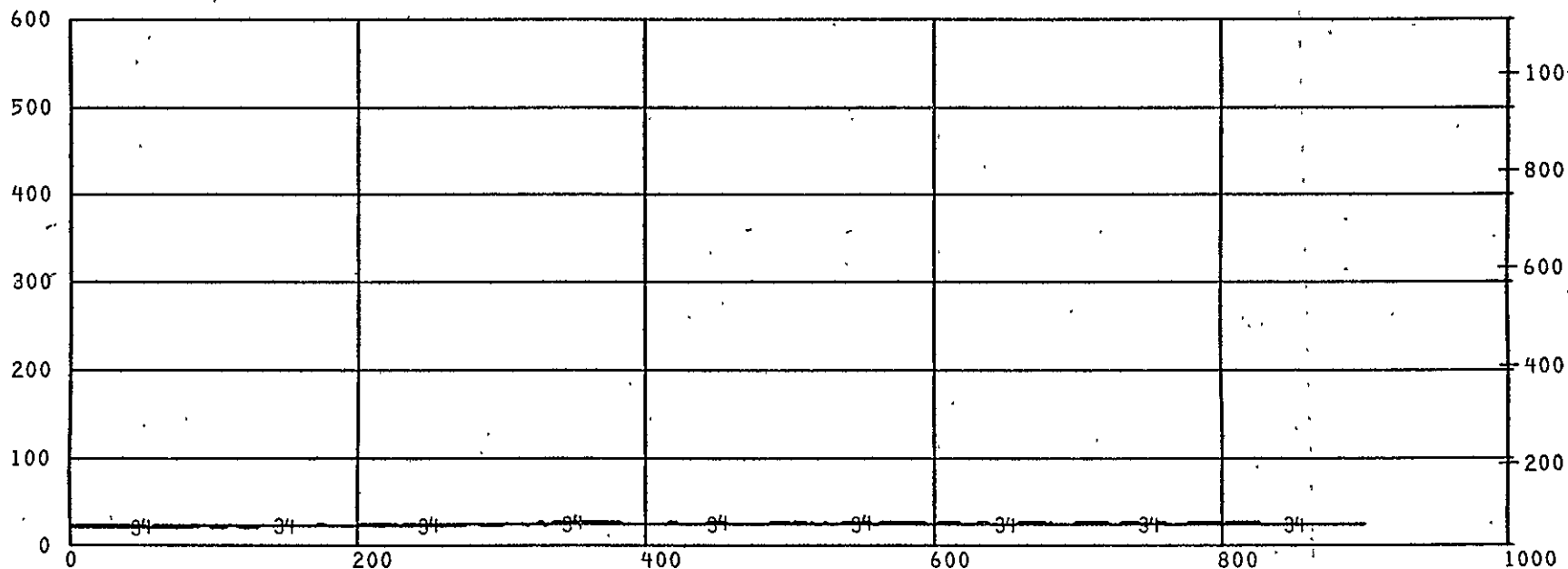
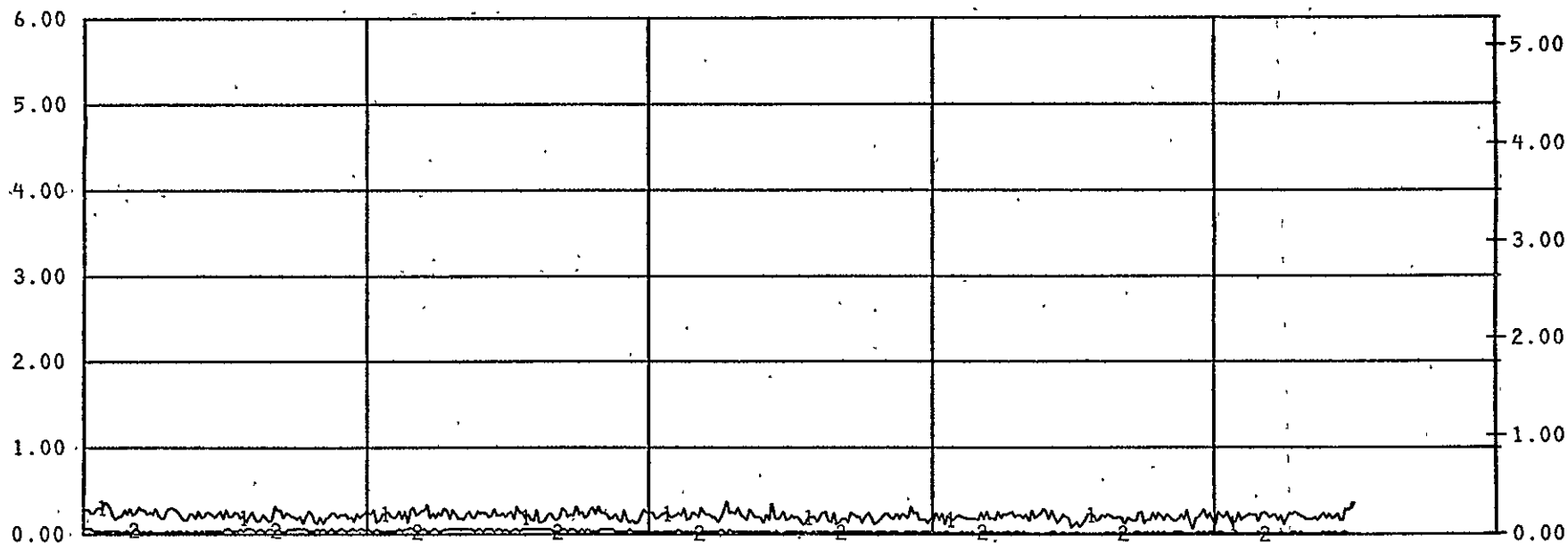
MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

RELATIVE TIME IN SEC
TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
1N-H20 A6



MEAS. NUMBER	CHANNEL ASGN.
\$ C1	
\$ C2	
\$ TC19	139
\$ TC20	120

TITLE
CALORIMETER OVER FIRE
CALORIMETER

RANGE
0.00 TO 6.00
0.00 TO 6.00
0 TO 600
0 TO 600

UNITS	GRID-SYM
WATT/CM2	A1
WATT/CM2	A2
DEG C	B3
DEG C	B4

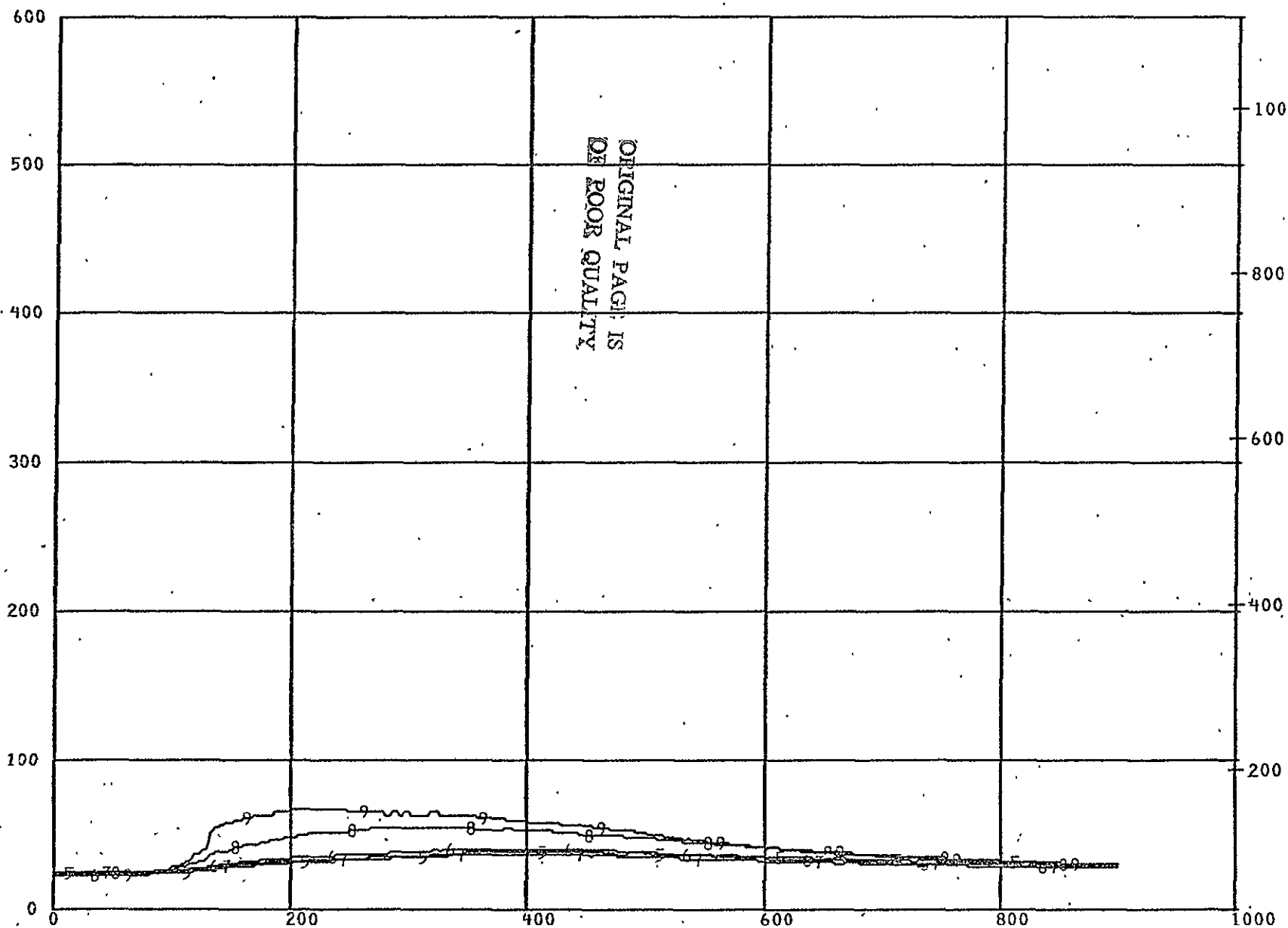
TEST ID 840288 082000

ST07

PLOT NO

2 - 1

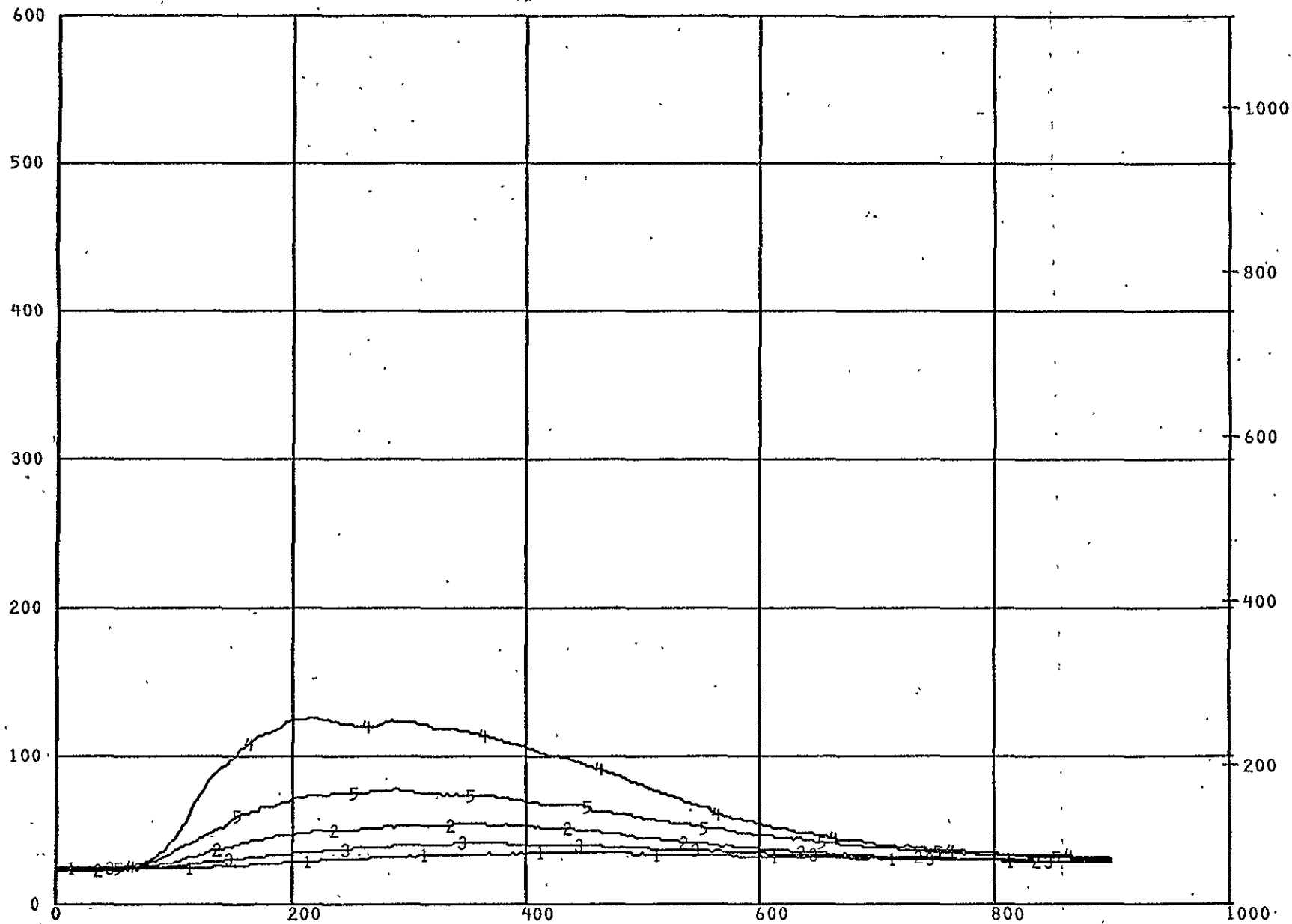
REFERENCE TIME 08 33 01.000

D
E
G
FRELATIVE TIME IN SEC
TITLE

MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

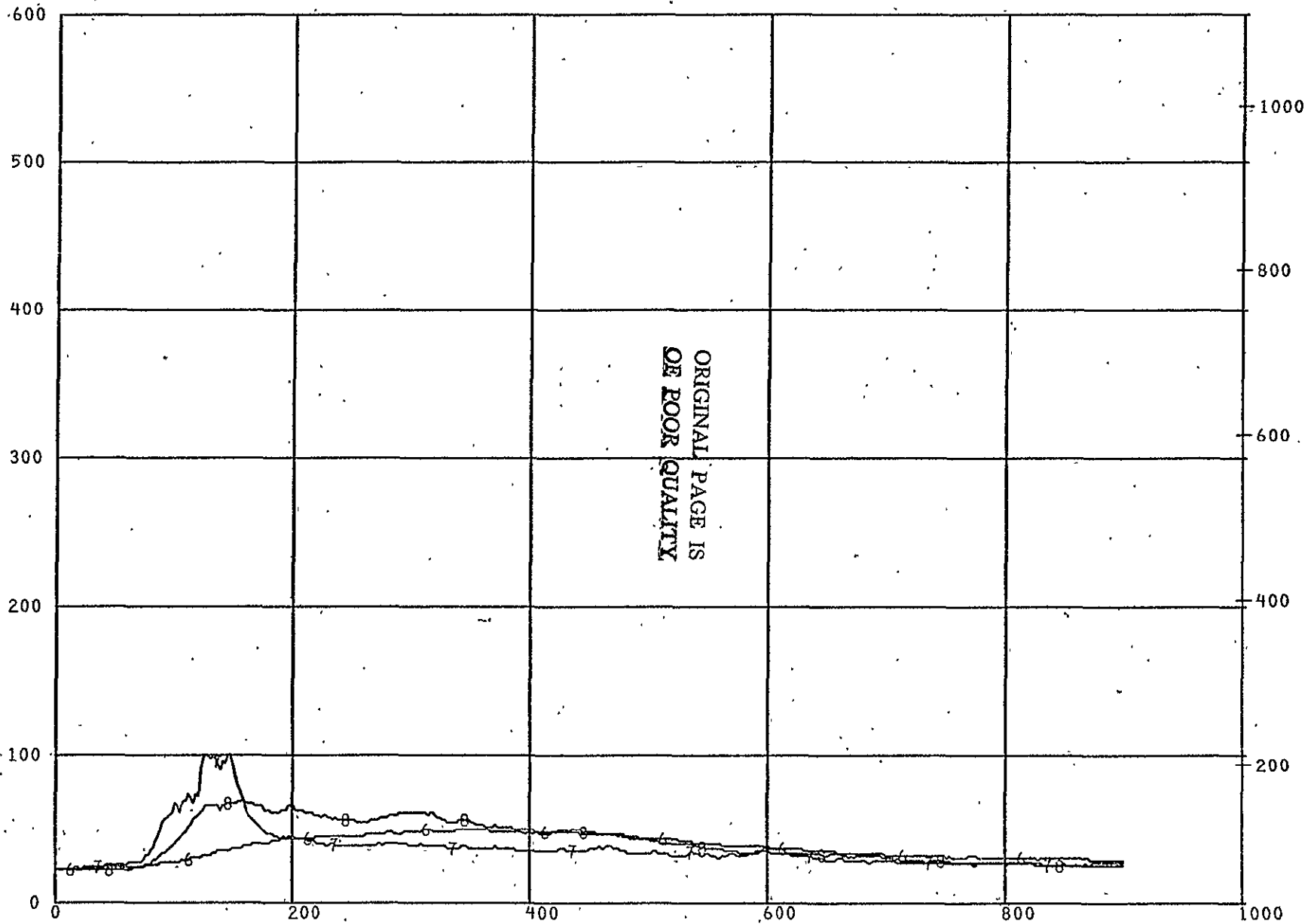
TEST ID 840288 082000

ST07

PLOT NO

4 - 1

REFERENCE TIME 08' 33 01.000

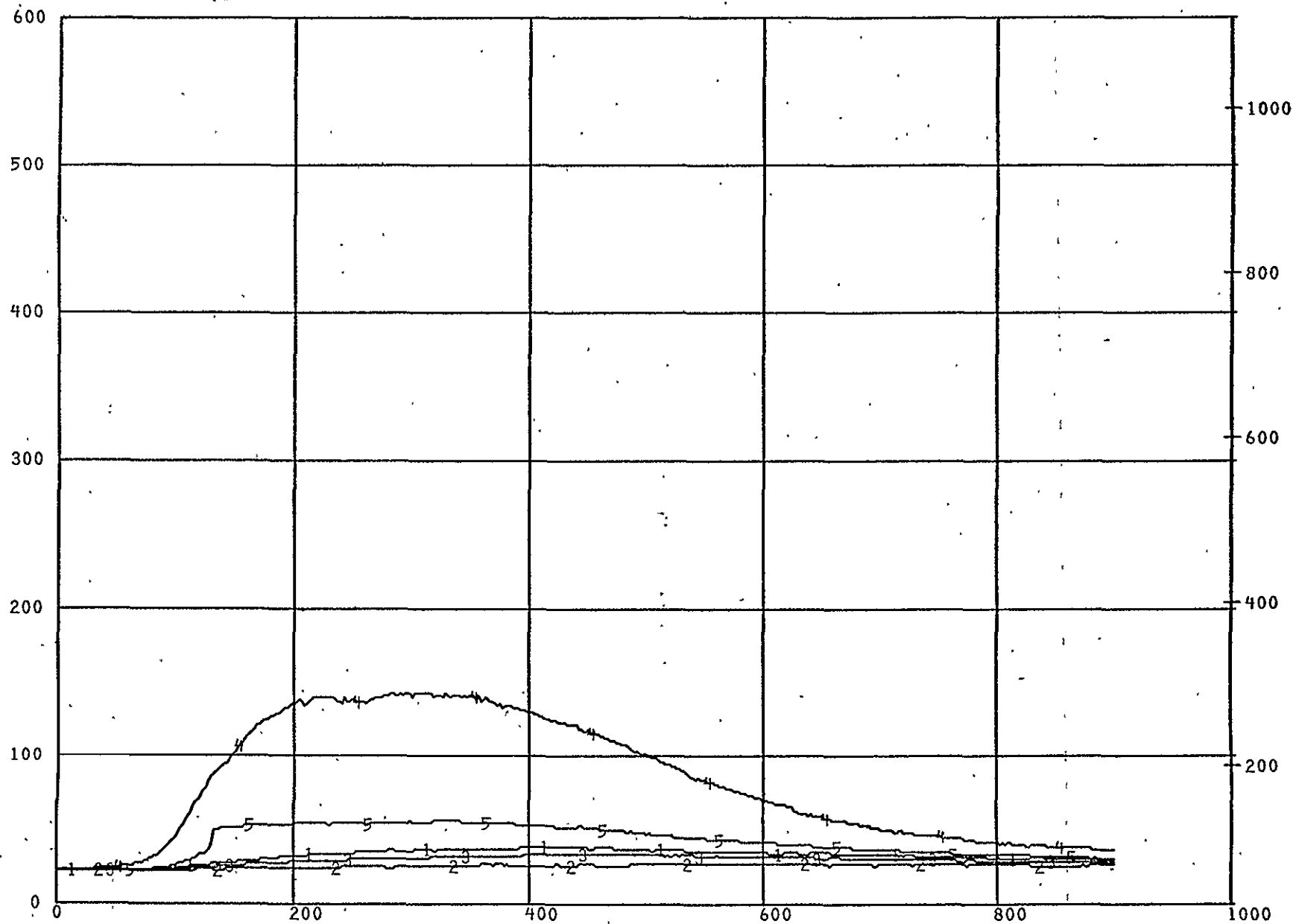
ORIGINAL PAGE IS
OF POOR QUALITYRELATIVE TIME IN SEC
TITLE

MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

216



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

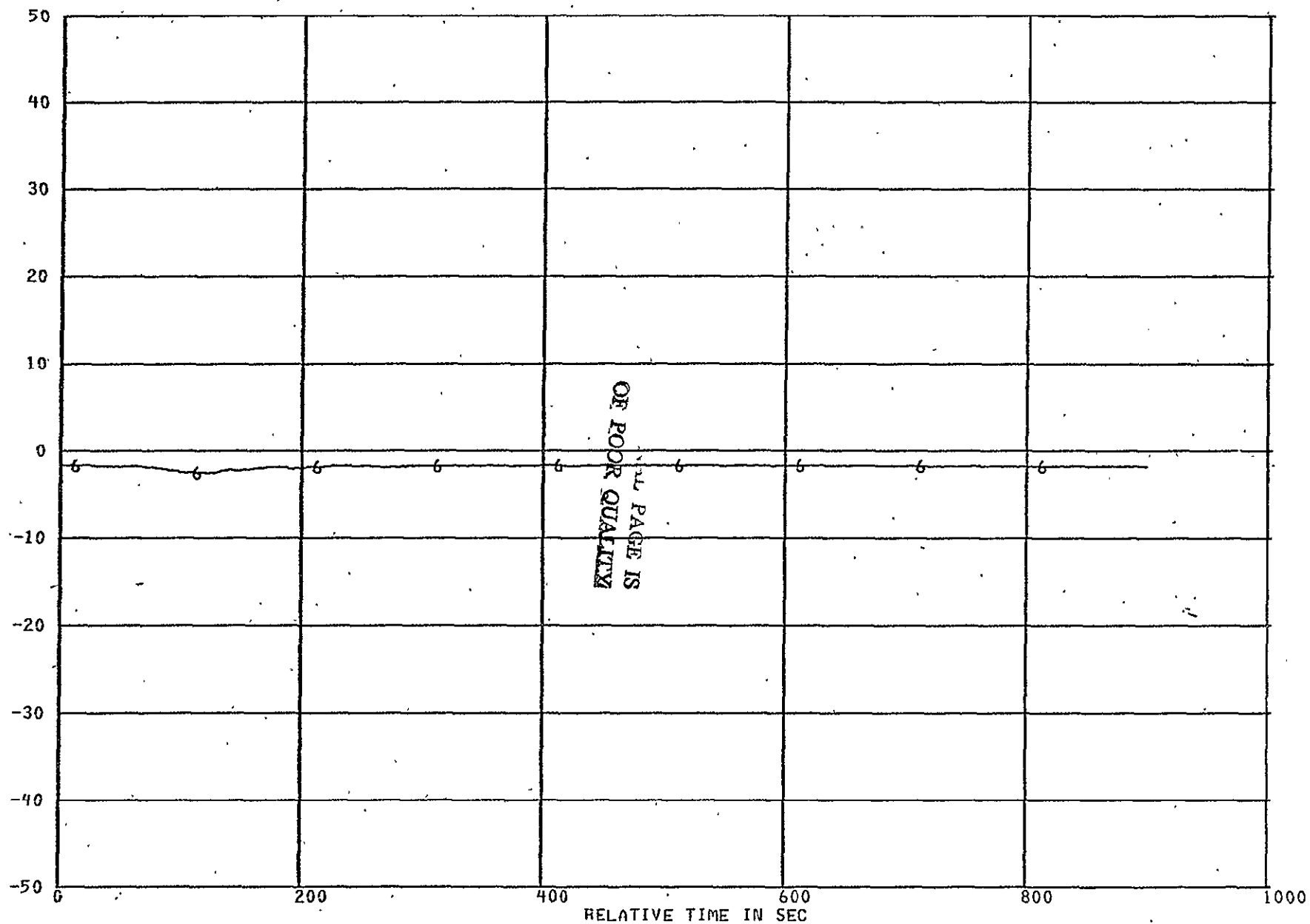
TEST ID 840288 082000

ST07

PLOT NO

6 - 1

REFERENCE TIME 08 33 01.000



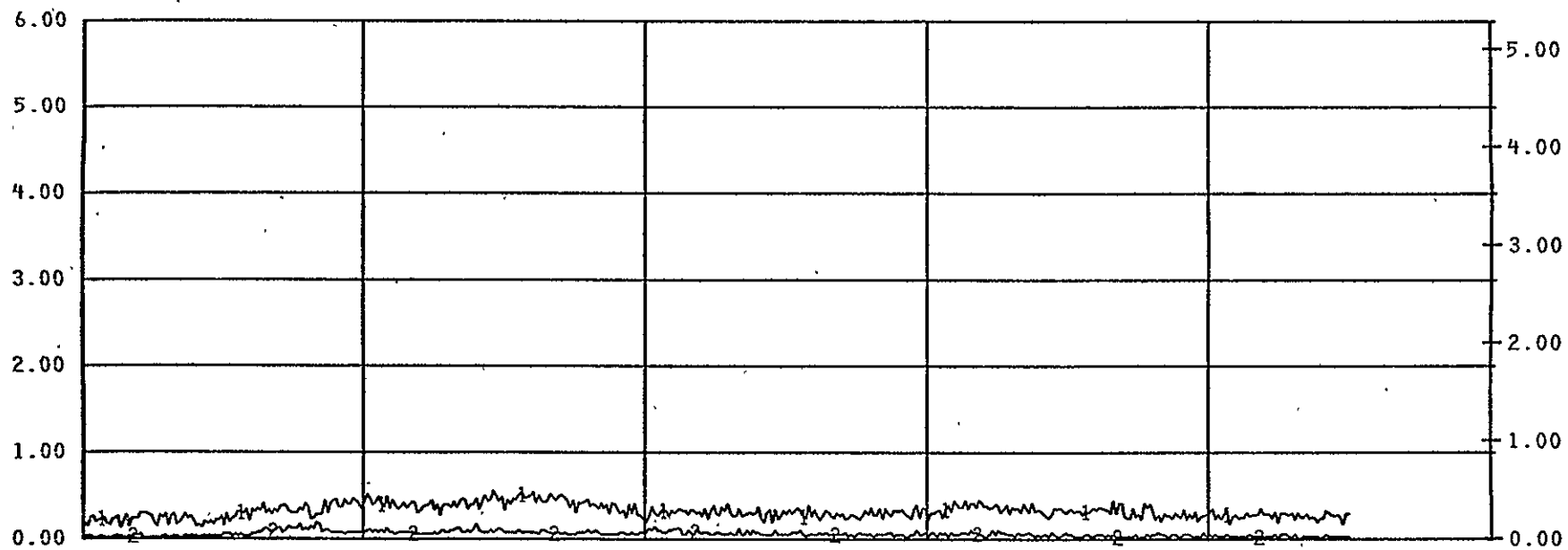
MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

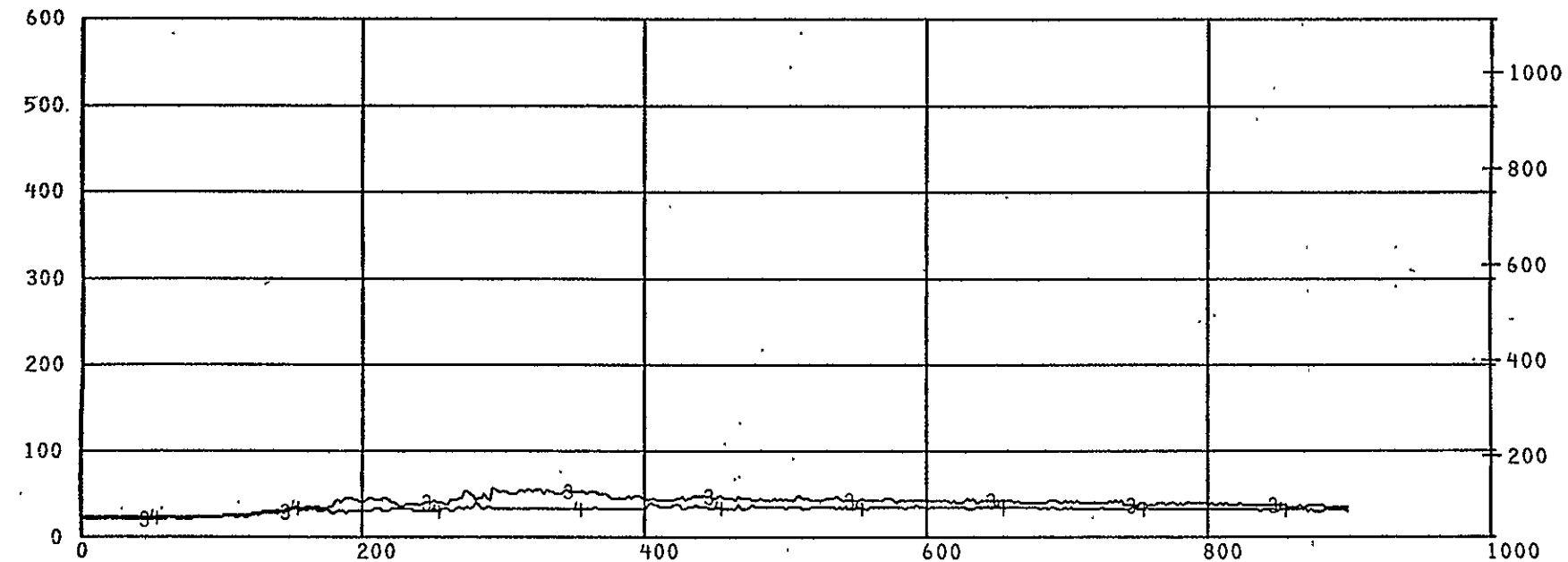
TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
IN-H20 A6



BTU/F2S



DEG F

218

MEAS. NUMBER	CHANNEL ASGN.	TITLE	RANGE	UNITS	GRID-SYM
\$ C1		CALORIMETER OVER FIRE	0.00 TO 6.00	WATT/CM2	A1
\$ C2		CALORIMETER	0.00 TO 6.00	WATT/CM2	A2
\$ TC19	139		0 TO 600	DEG C	B3
\$ TC20	120		0 TO 600	DEG C	B4

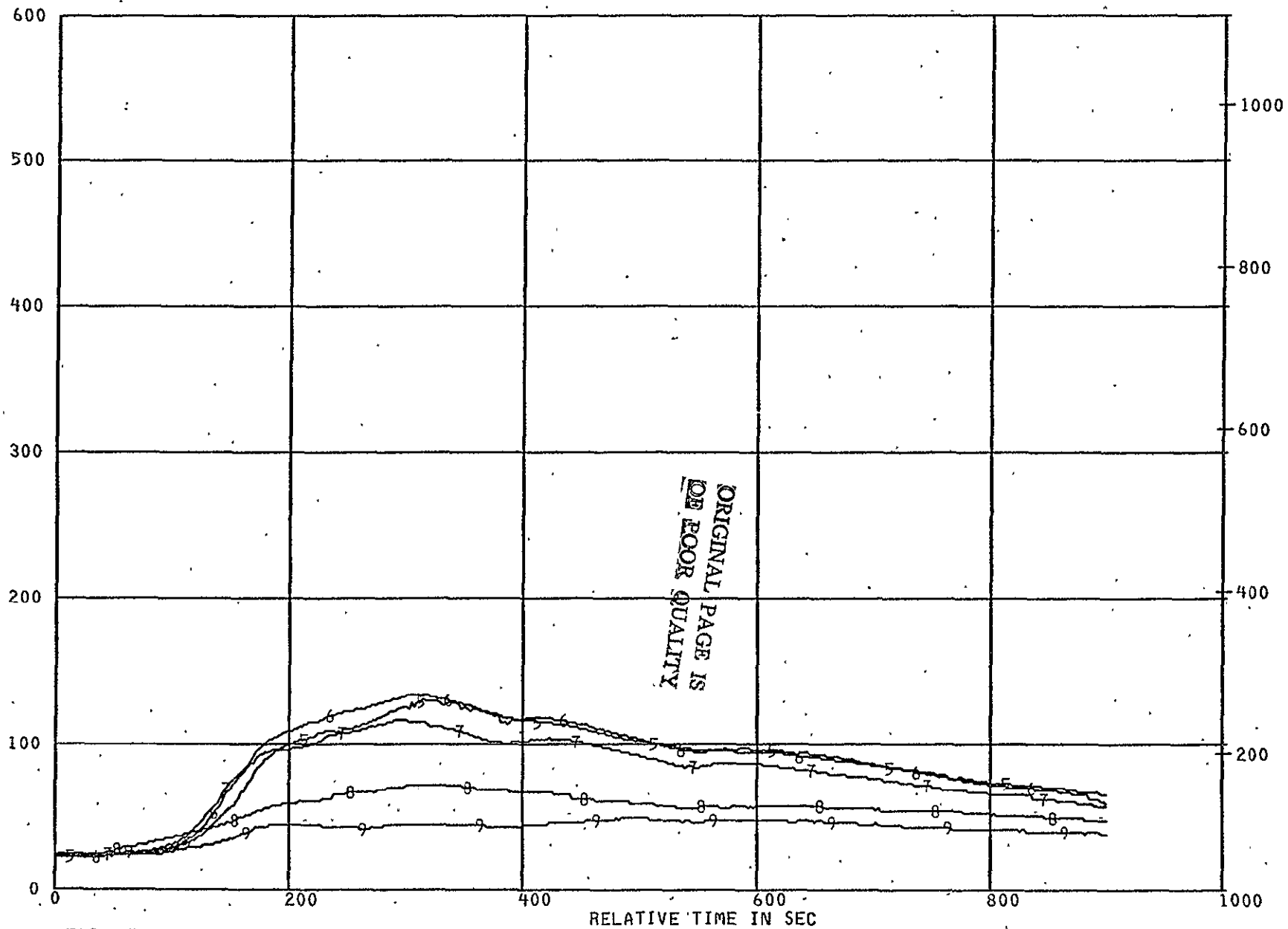
TEST ID 840288 082000

ST08

PLOT NO

2 - 1

REFERENCE TIME 09 12 01.000



MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

TITLE

RANGE

0 TO 600

0 TO 600

0 TO 600

0 TO 600

0 TO 600

UNITS

DEG C

DEG C

DEG C

DEG C

DEG C

GRID-SYM

A5

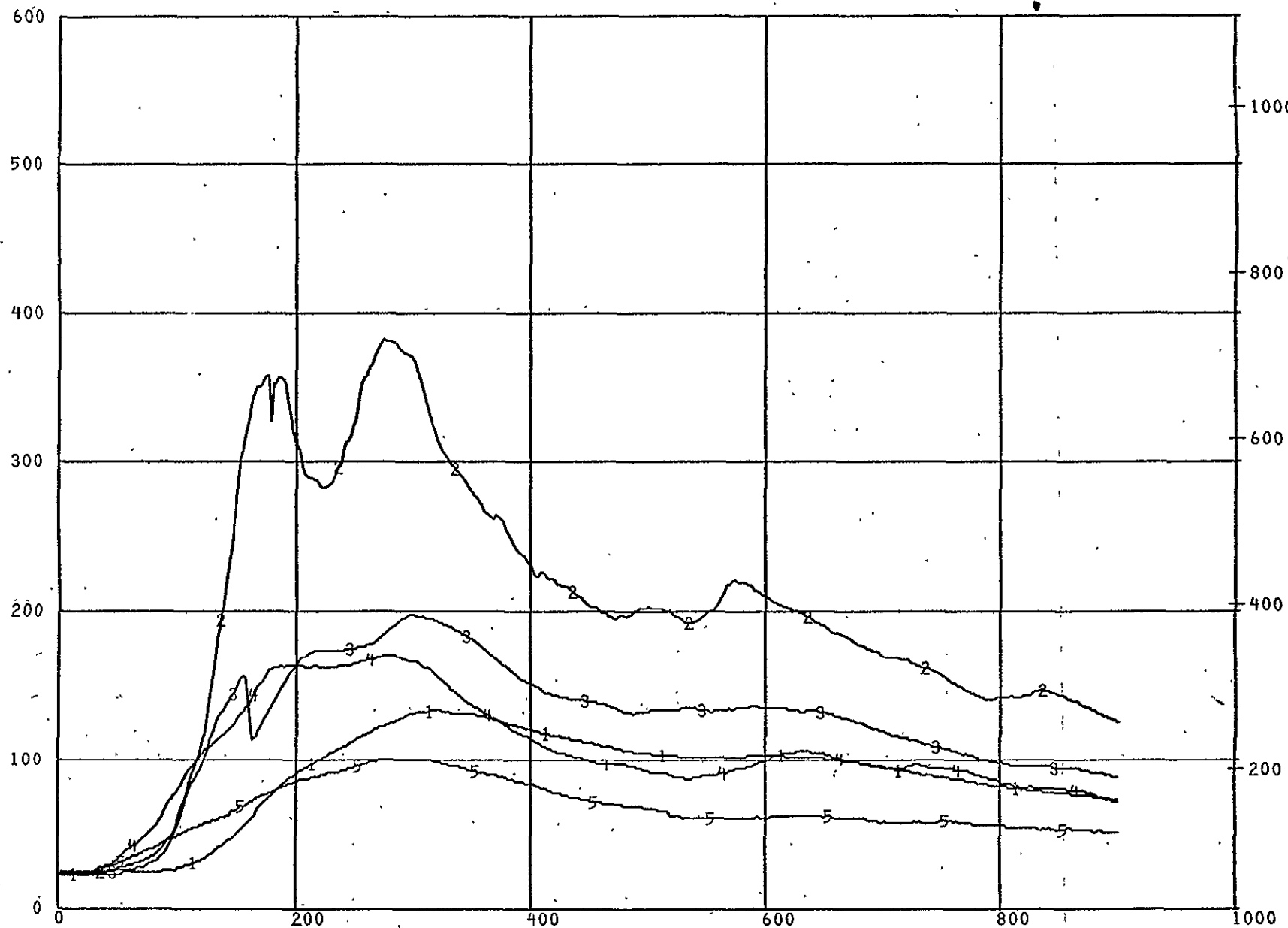
A6

A7

A8

A9

220



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE.
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 082000

ST08

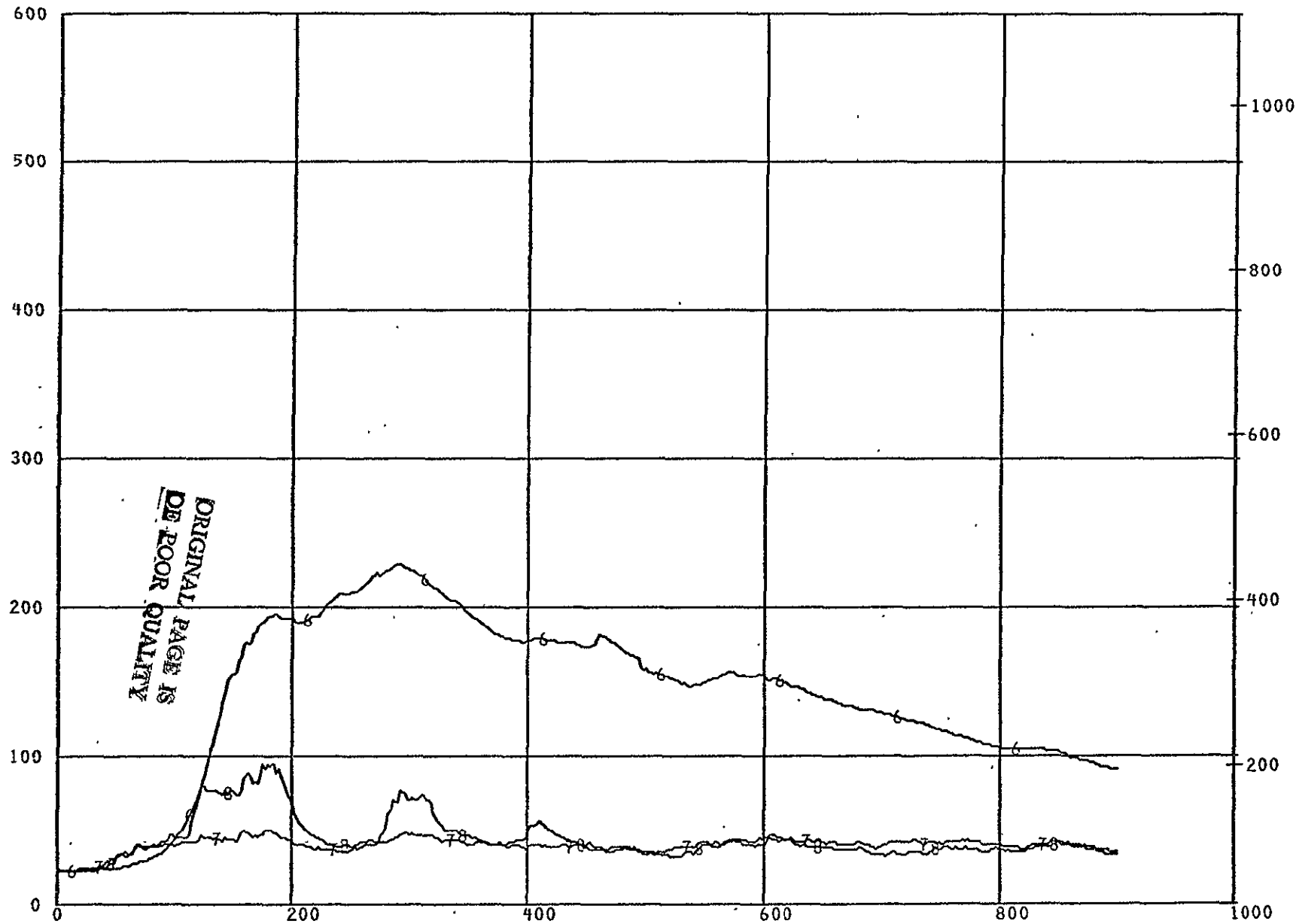
PLOT NO

4 - 1

REFERENCE TIME 09 12 01.000

D
E
G
F

221



MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

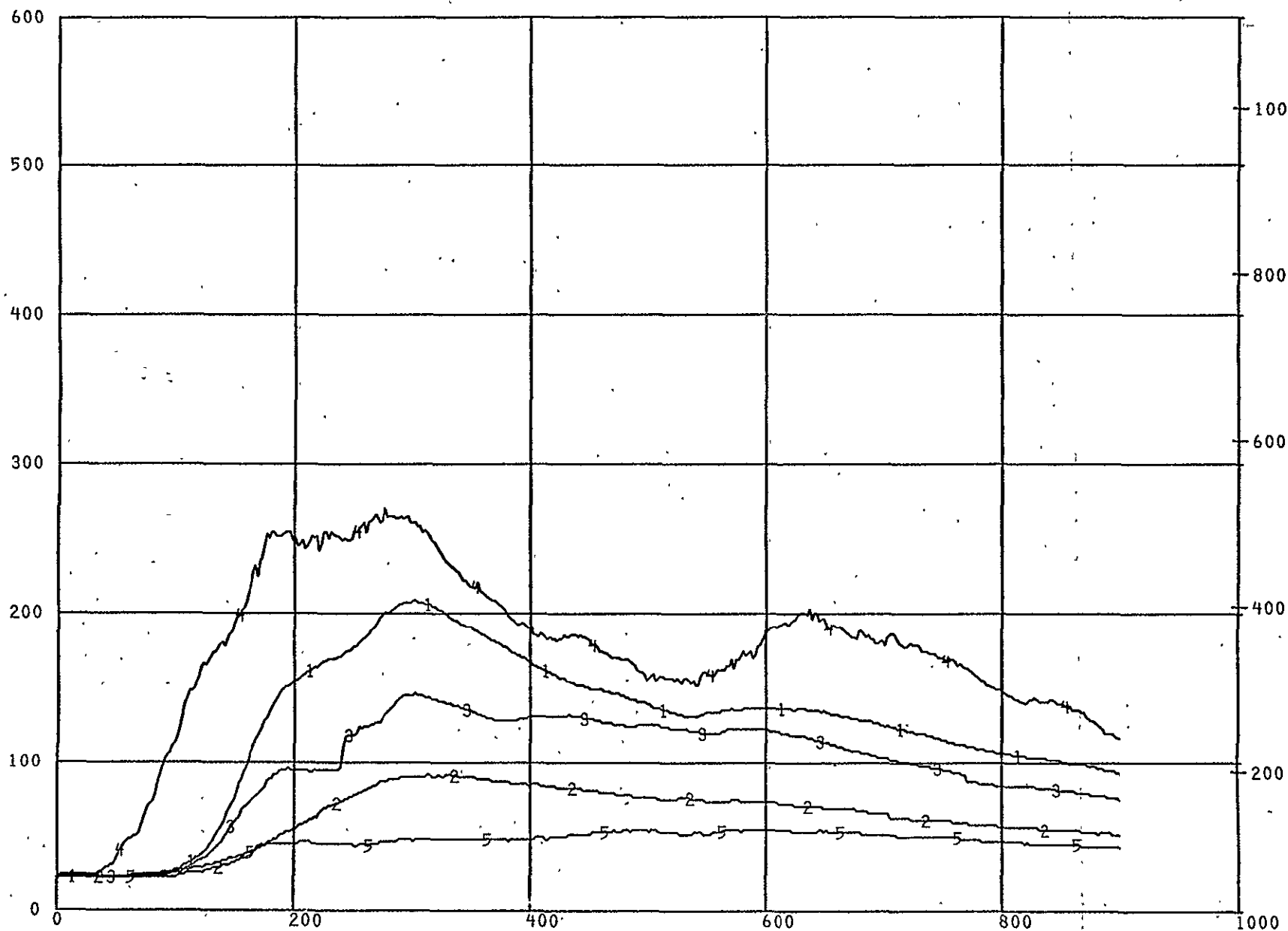
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

D
E
G
F

222



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

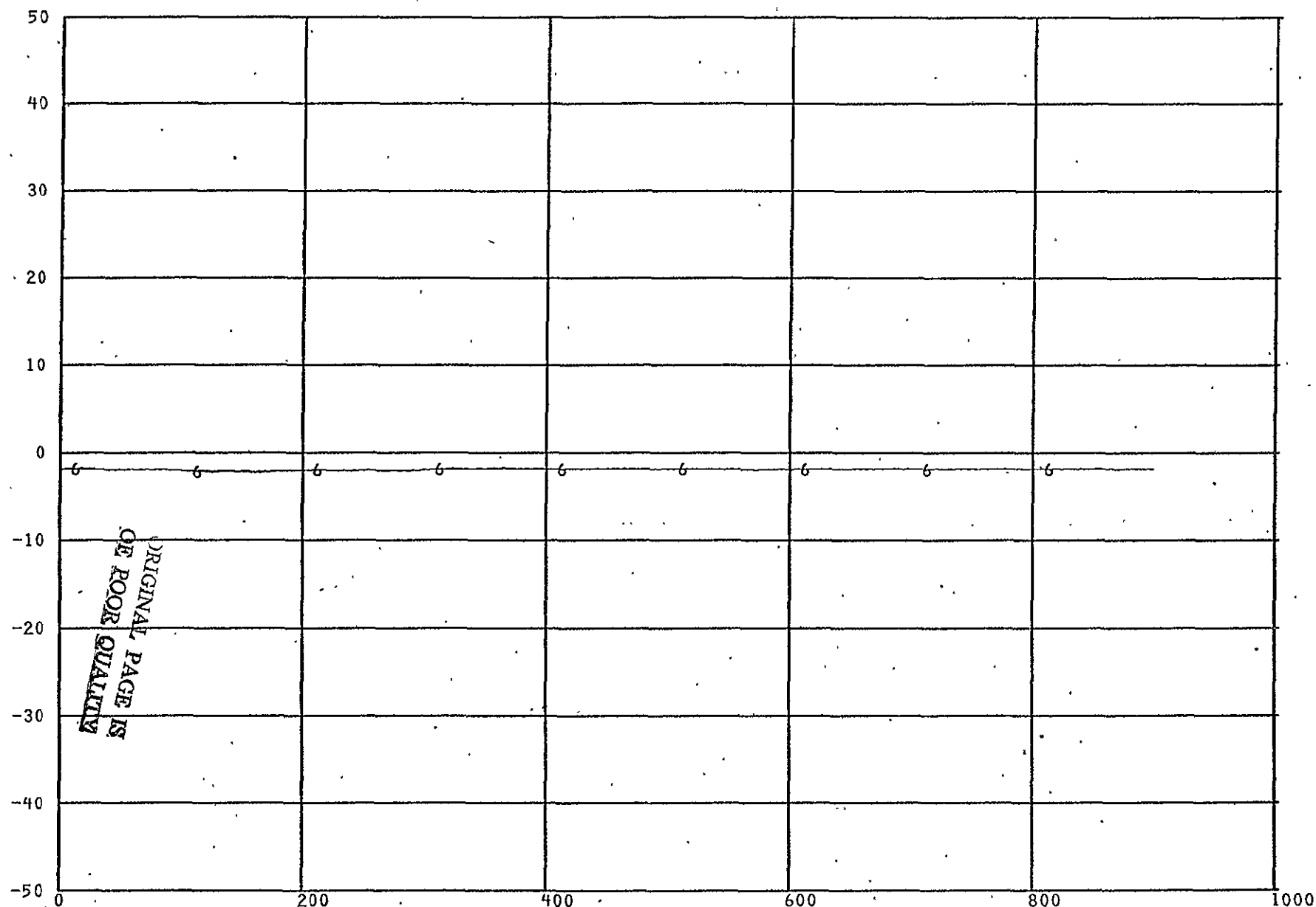
UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 082000

ST08

PLOT NO 6 - 1

REFERENCE TIME 09 12 01.000



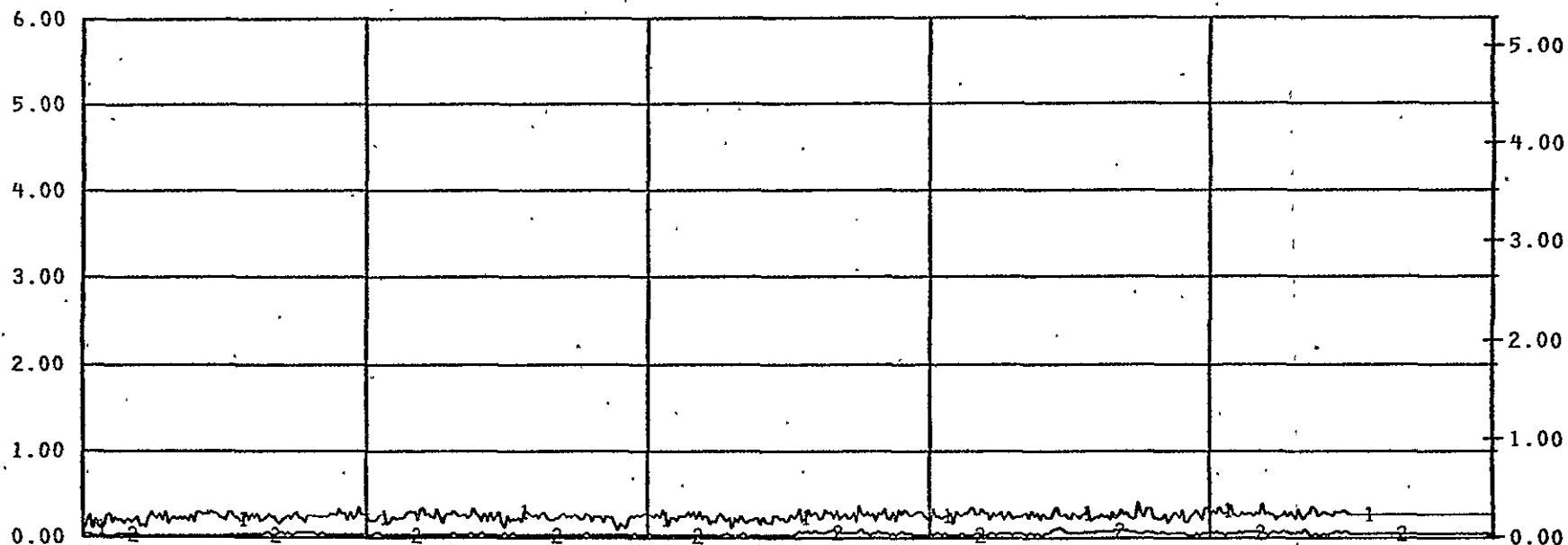
MEAS. NUMBER
PRESS

CHANNEL ASGN:
098

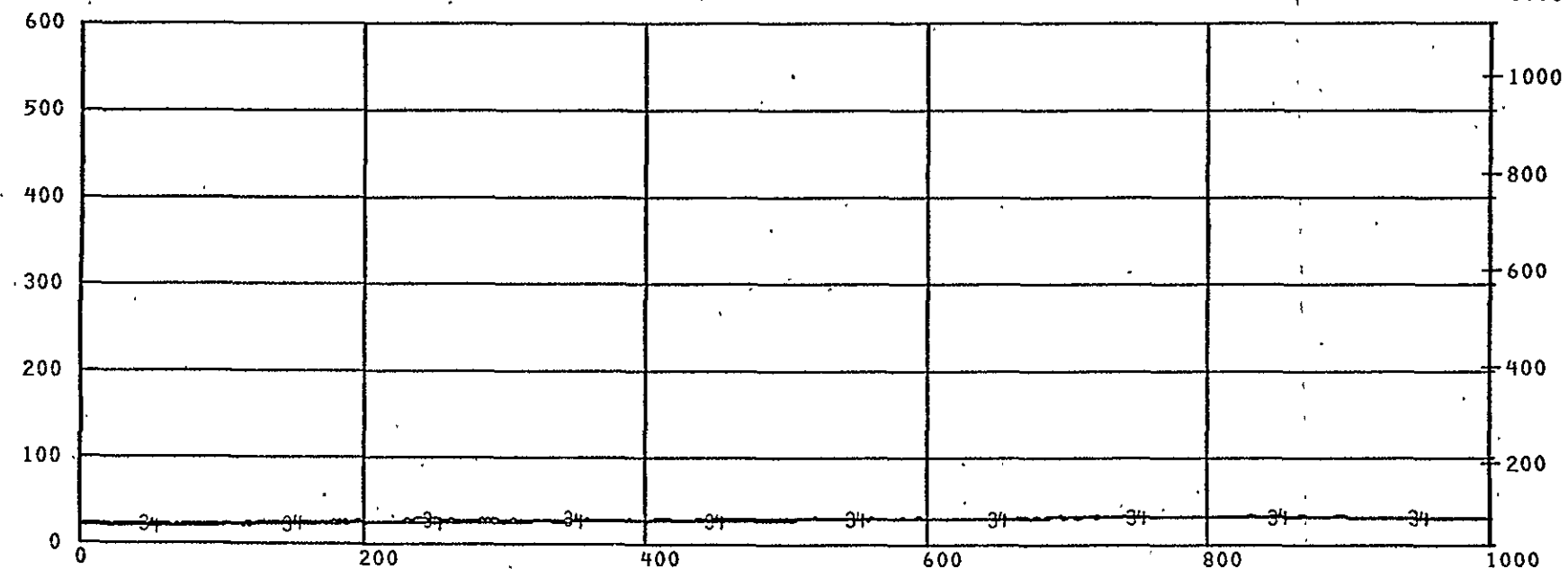
RELATIVE TIME IN SEC
TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
1N-H20 A6



BTU/F2S



DEG F

MEAS. NUMBER CHANNEL ASGN.
\$ C1
\$ C2
\$ TC19 139
\$ TC20 120

RELATIVE TIME IN SEC
TITLE
CALORIMETER OVER FIRE
CALORIMETER

RANGE
0.00 TO 6.00
0.00 TO 6.00
0 TO 600
0 TO 600

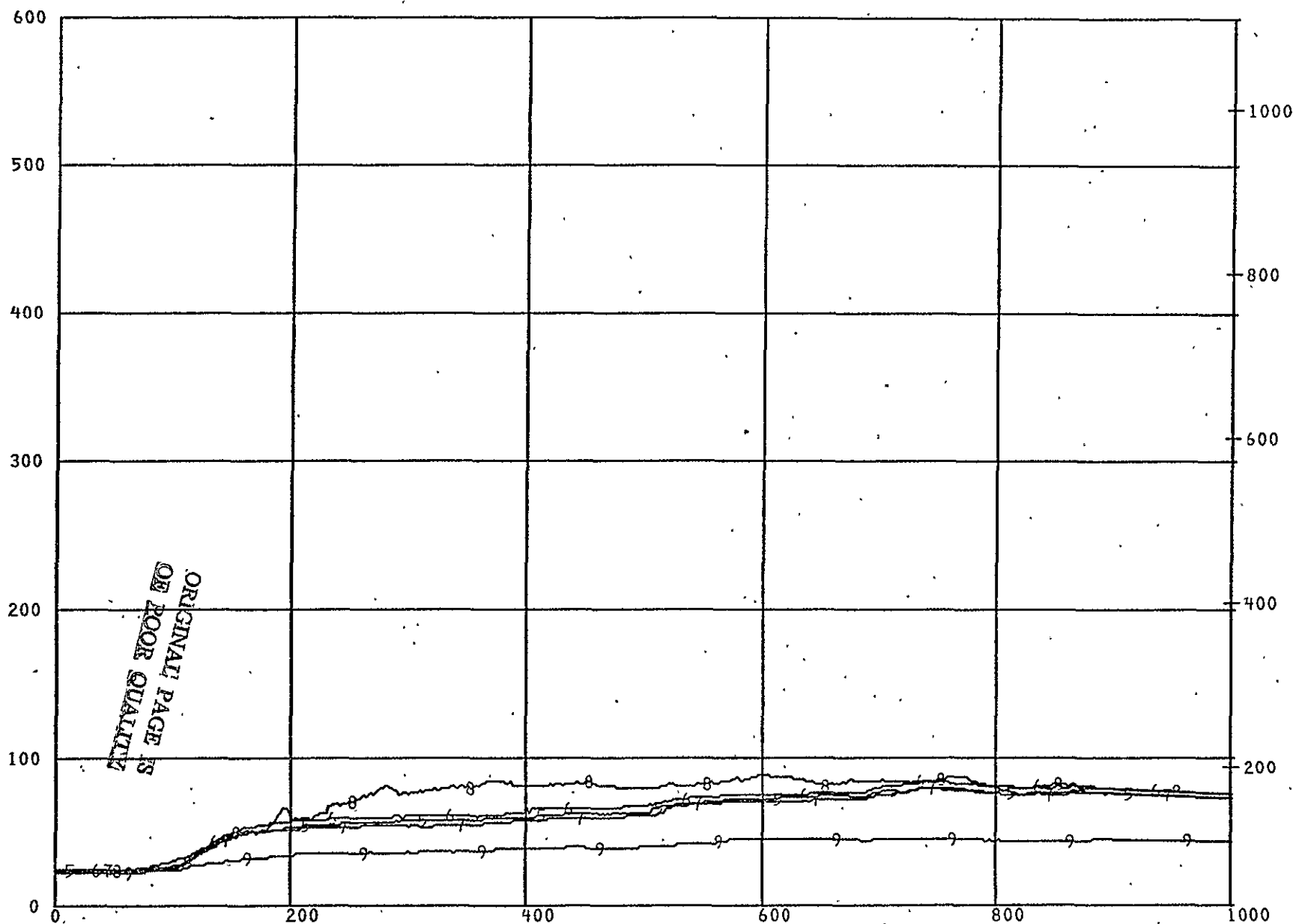
UNITS GRID-SYM
WATT/CM2 A1
WATT/CM2 A2
DEG C B3
DEG C B4

TEST ID 840288 082000

ST09

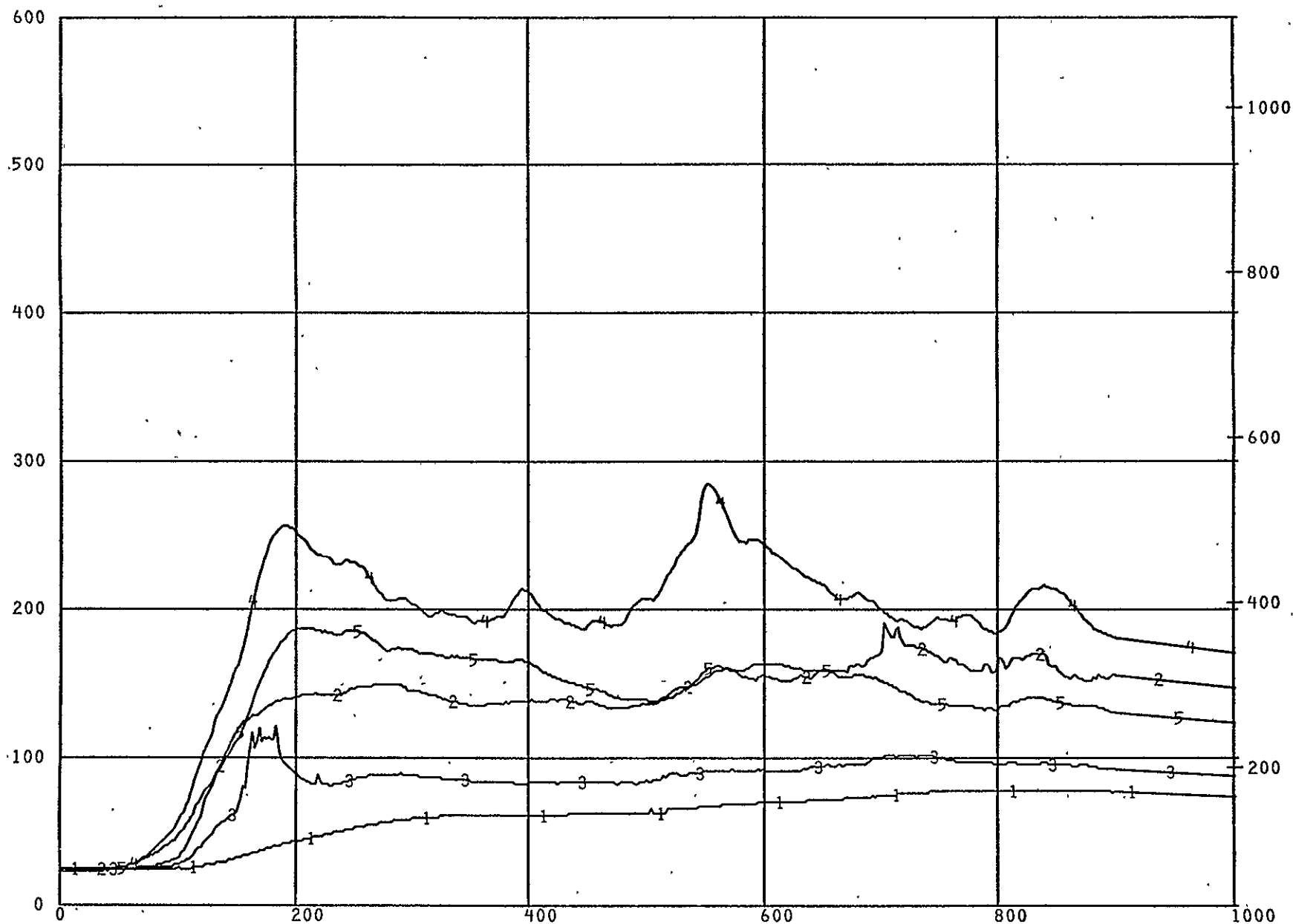
PLOT NO 2 - 1

REFERENCE TIME 10 33 00.000

D
E
G
F

MEAS. NUMBER	CHANNEL ASGN.	TITLE	RANGE	UNITS	GRID-SYM
\$ TC05	105		0 TO 600	DEG C	A5
\$ TC06	106		0 TO 600	DEG C	A6
\$ TC07	107		0 TO 600	DEG C	A7
\$ TC12	132		0 TO 600	DEG C	A8
\$ TC13	133		0 TO 600	DEG C	A9

226



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

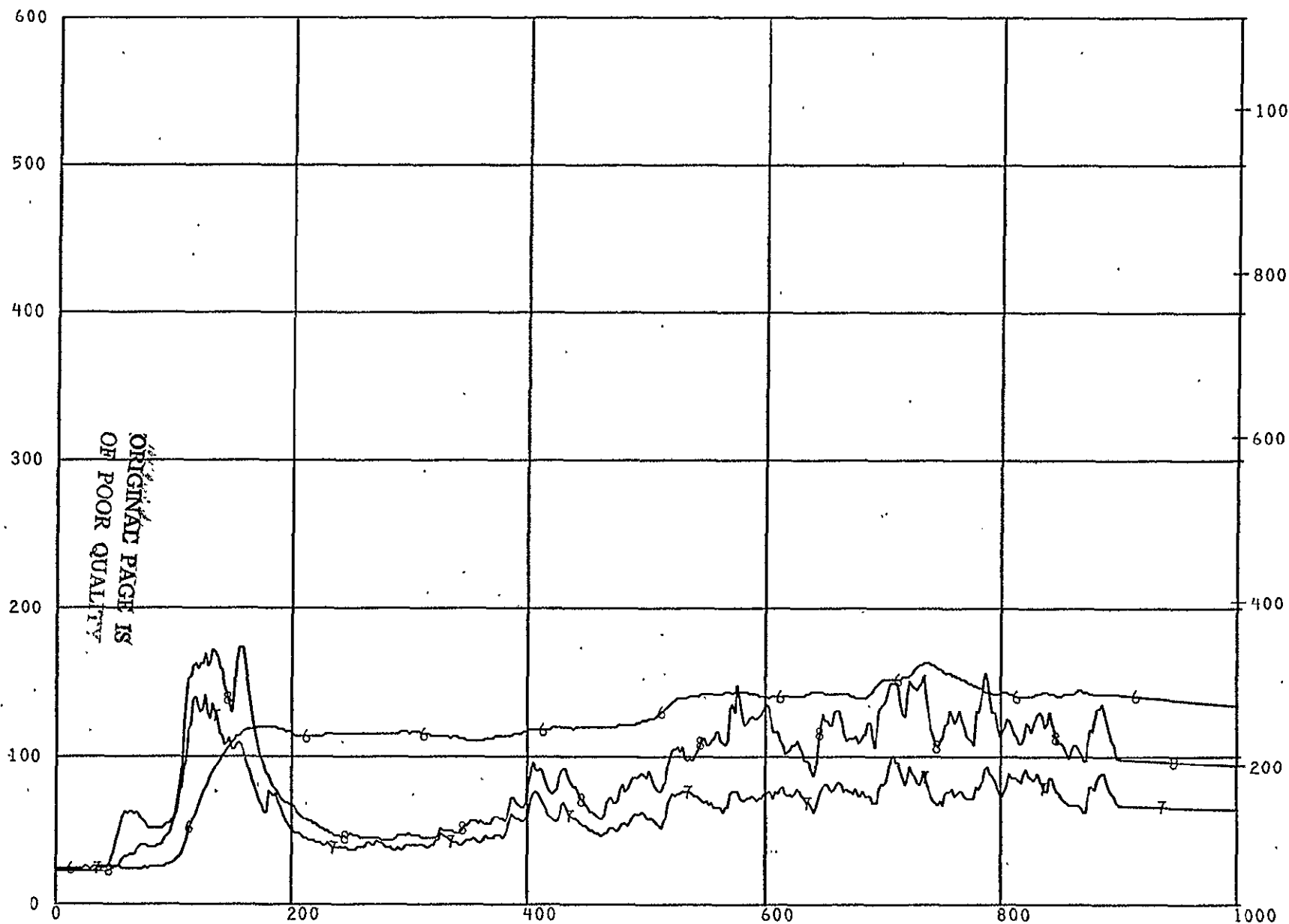
TEST ID 840288 082000

ST09

PLOT NO

4 - 1

REFERENCE TIME 10 33 00.000

D
E
G
F

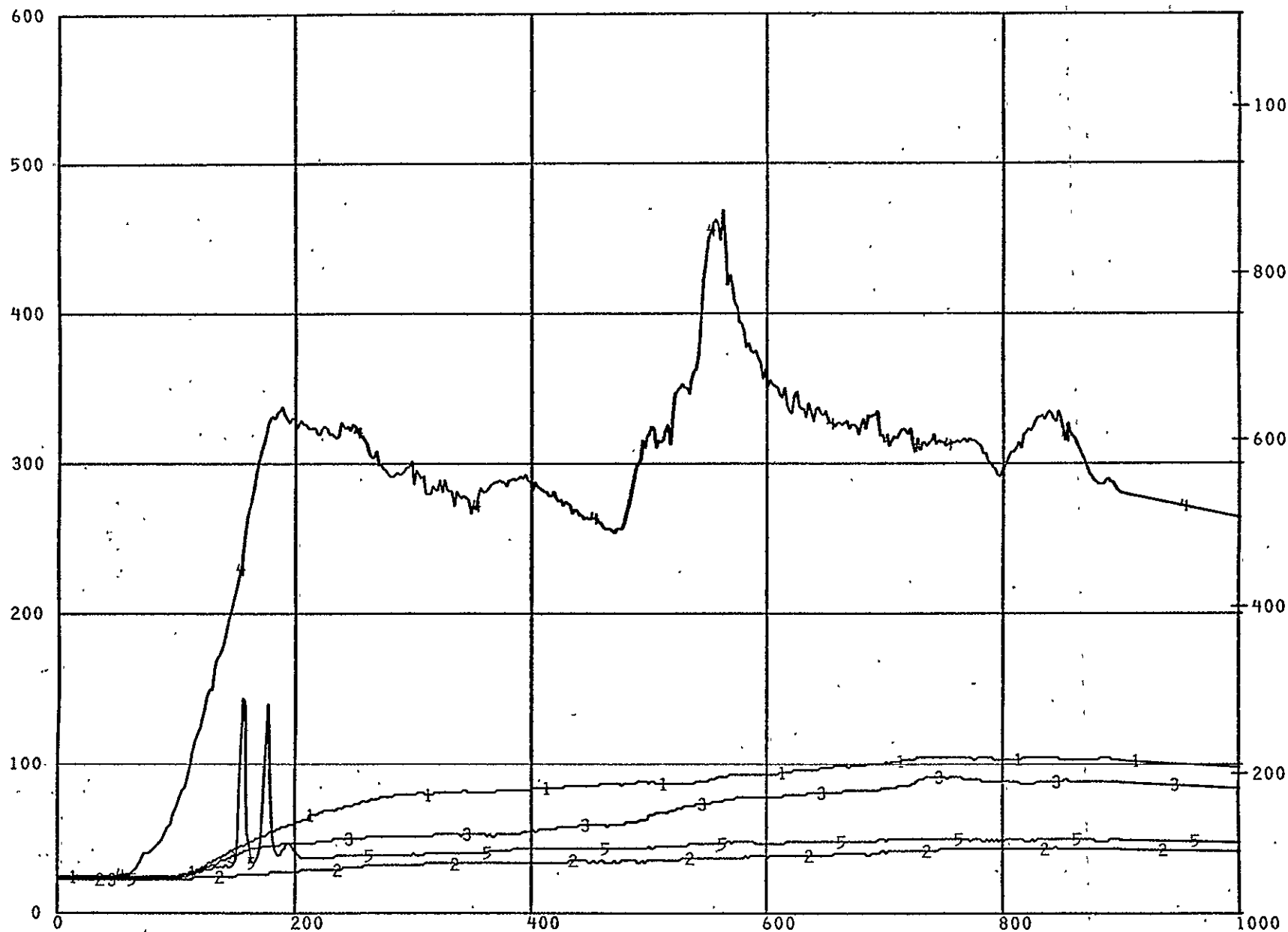
MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

228



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

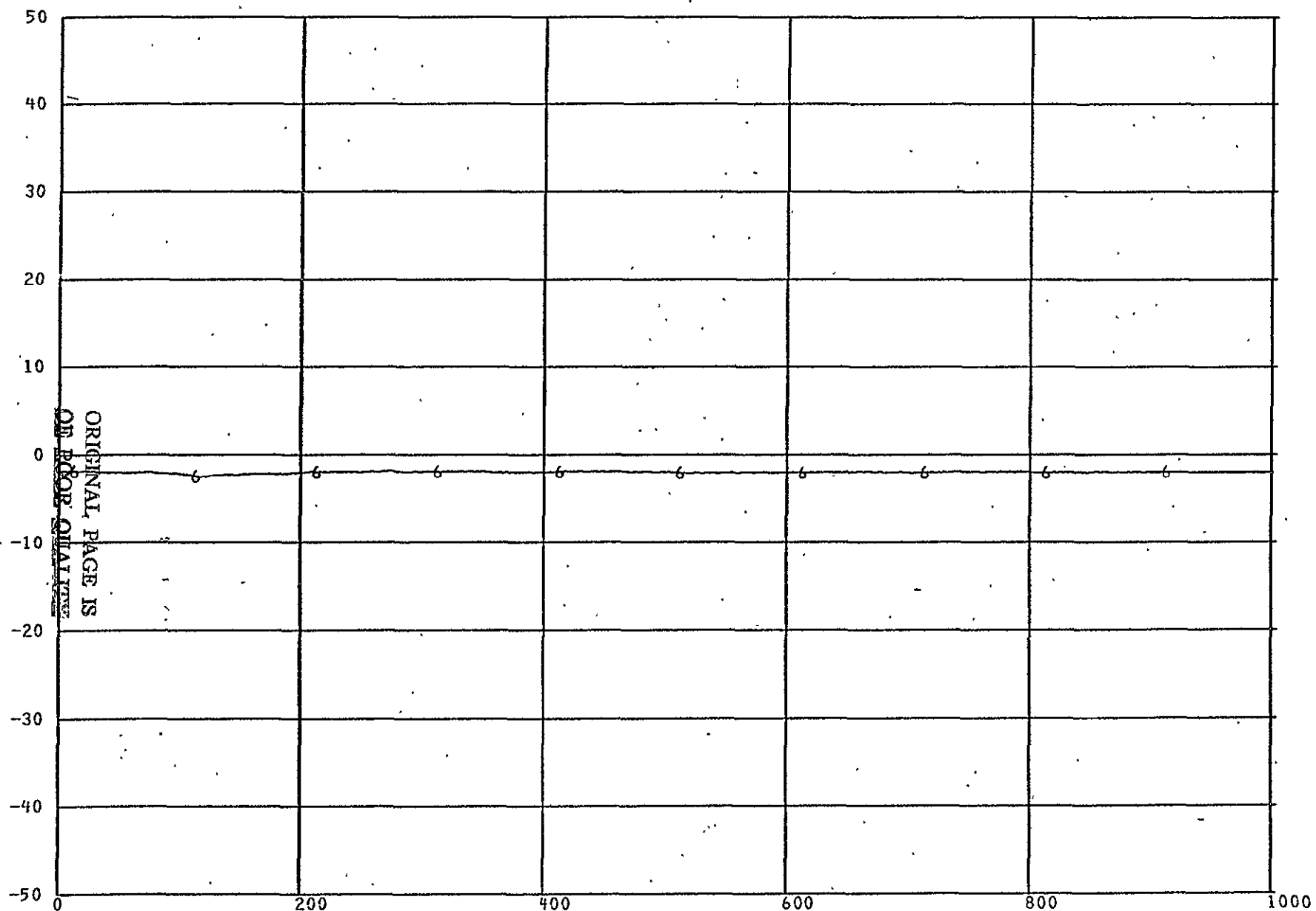
TEST ID 840288 082000

ST09

PLOT NO

6 - 1

REFERENCE TIME 10 33 00.000



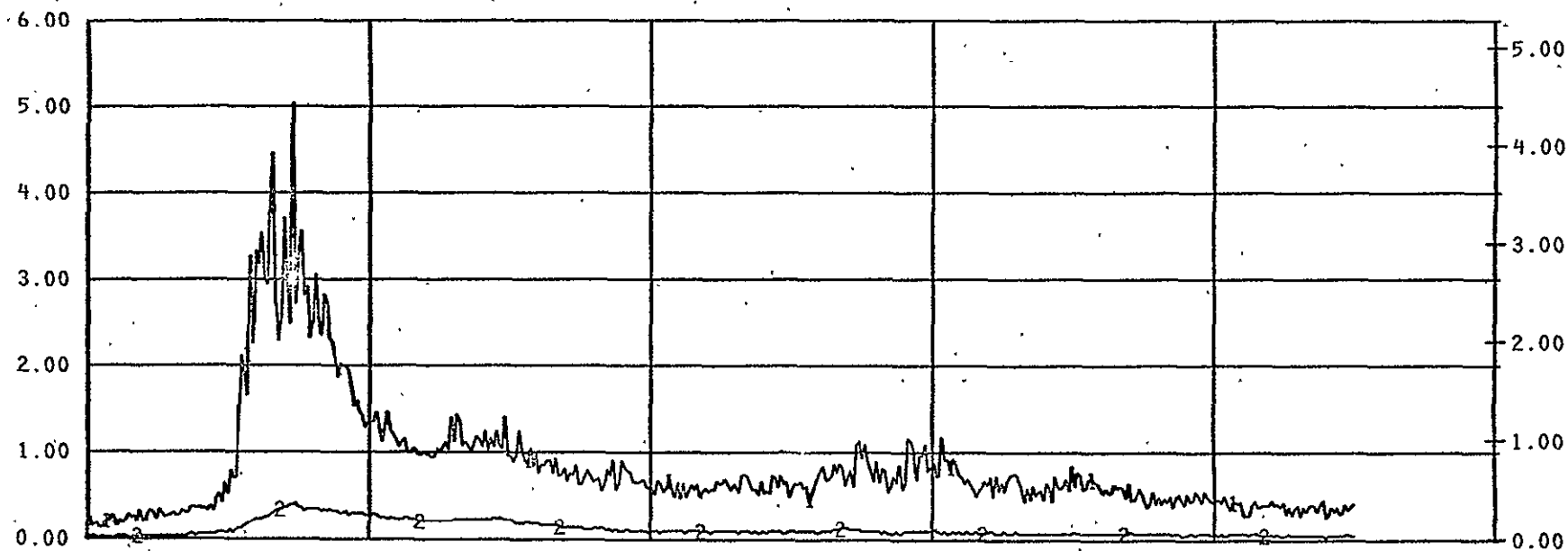
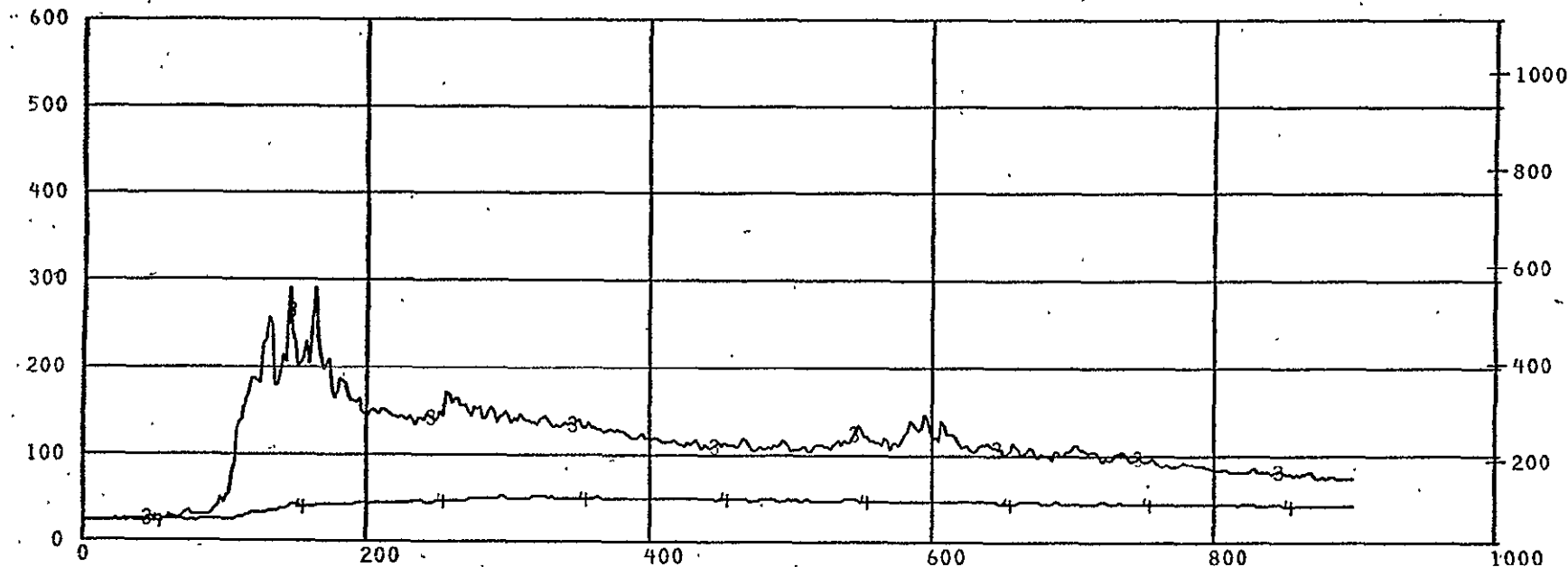
MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
1N-H20 A6

B
T
U
/
F
2
SD
E
G
C

MEAS. NUMBER	CHANNEL ASGN.
\$ C1	
\$ C2	
\$ TC19	139
\$ TC20	120

TITLE
CALORIMETER OVER FIRE
CALORIMETER

RANGE
0.00 TO 6.00
0.00 TO 6.00
0 TO 600
0 TO 600

UNITS	GRID-SYM
WATT/CM2	A1
WATT/CM2	A2
DEG C	B3
DEG C	B4

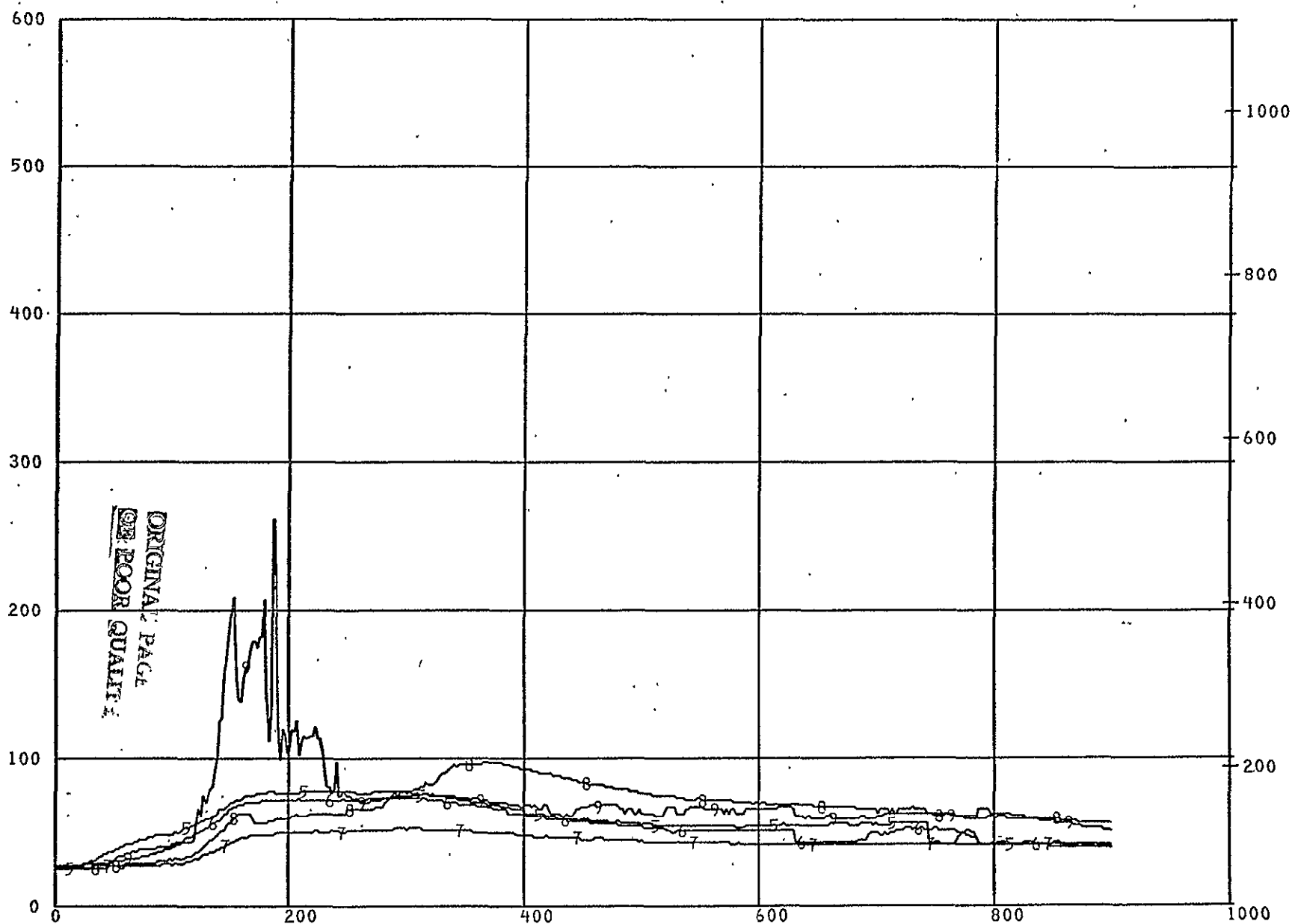
TEST ID 840288 082000

ST10

PLOT NO

2 - 1

REFERENCE TIME 14 50 01.000

D
E
G
F

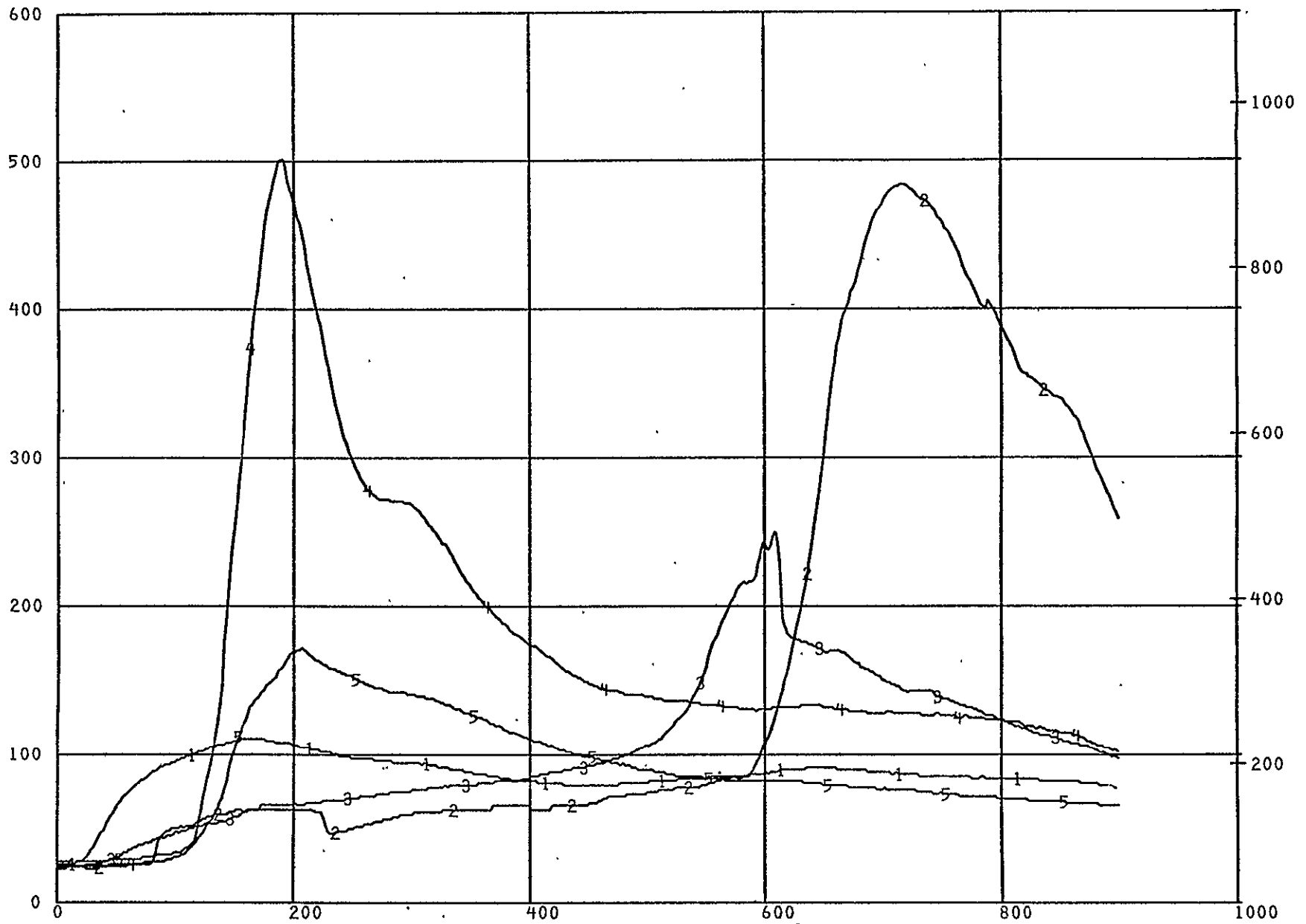
MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

232



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 082000

ST10

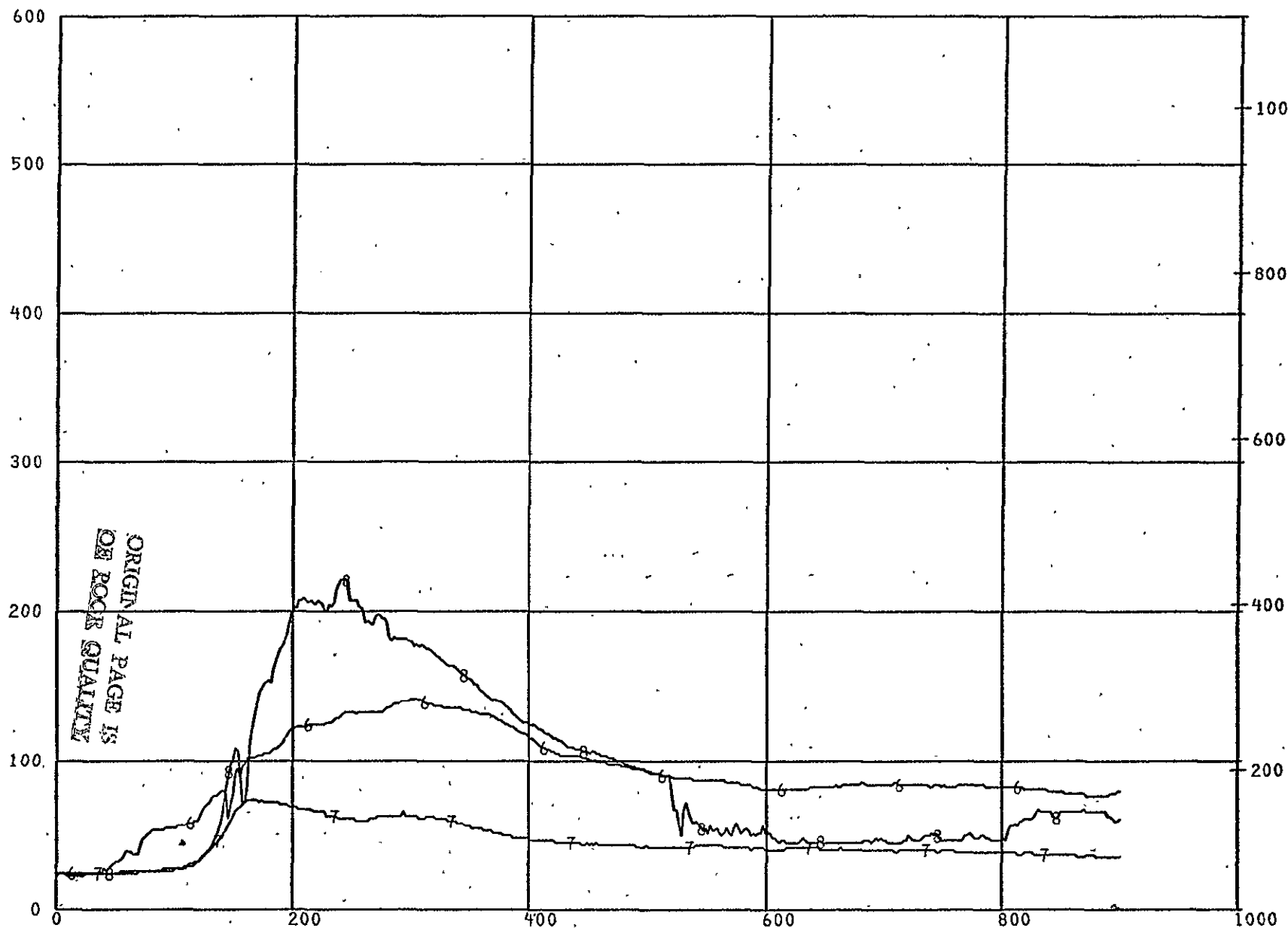
PLOT NO

4 - 1

REFERENCE TIME 14 50 01.000

D
E
G
F

233

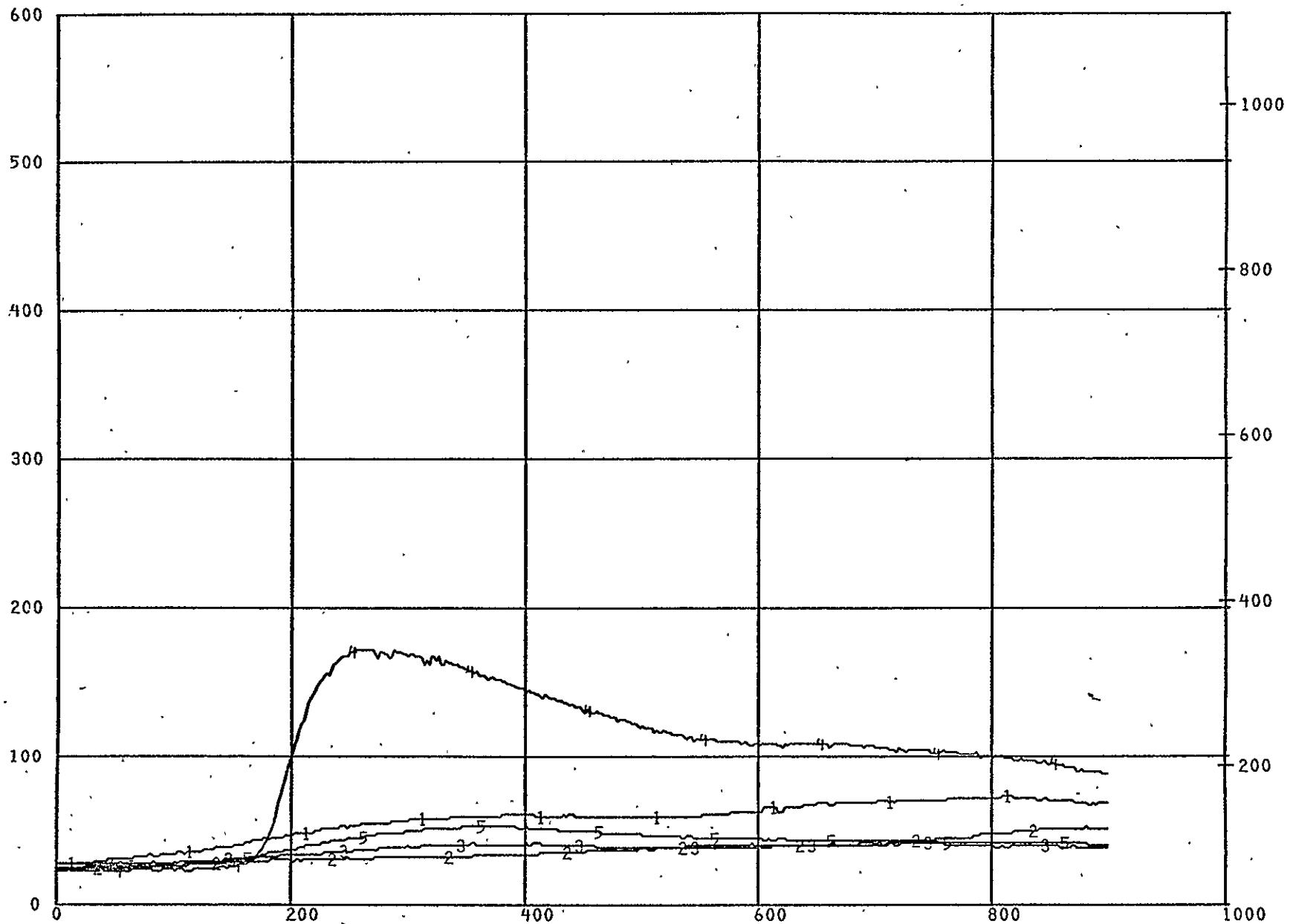


MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

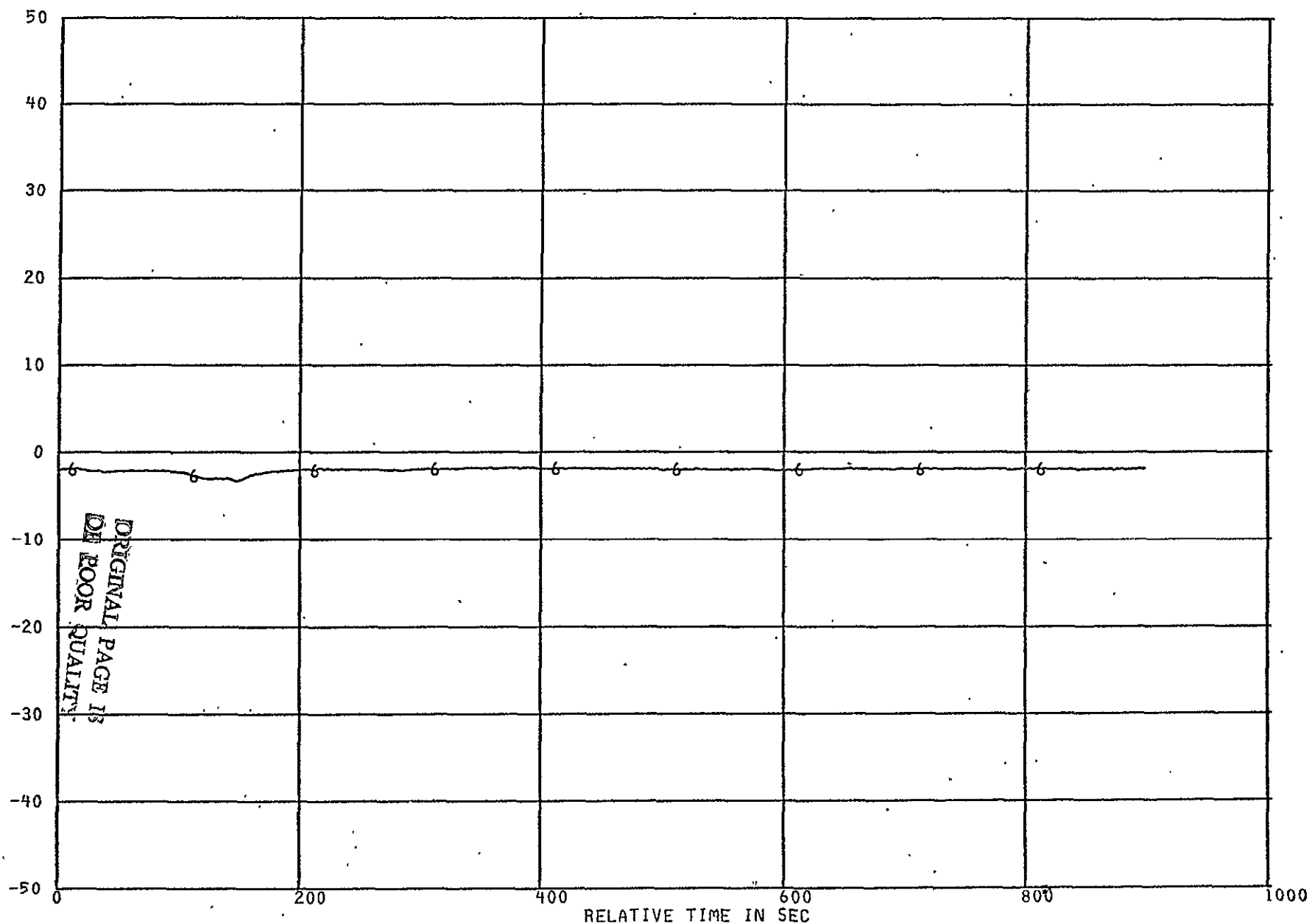
TEST ID 840288 082000

ST10

PLOT NO

6 - 1

REFERENCE TIME 14 50 01.000



MEAS. NUMBER
PRESS

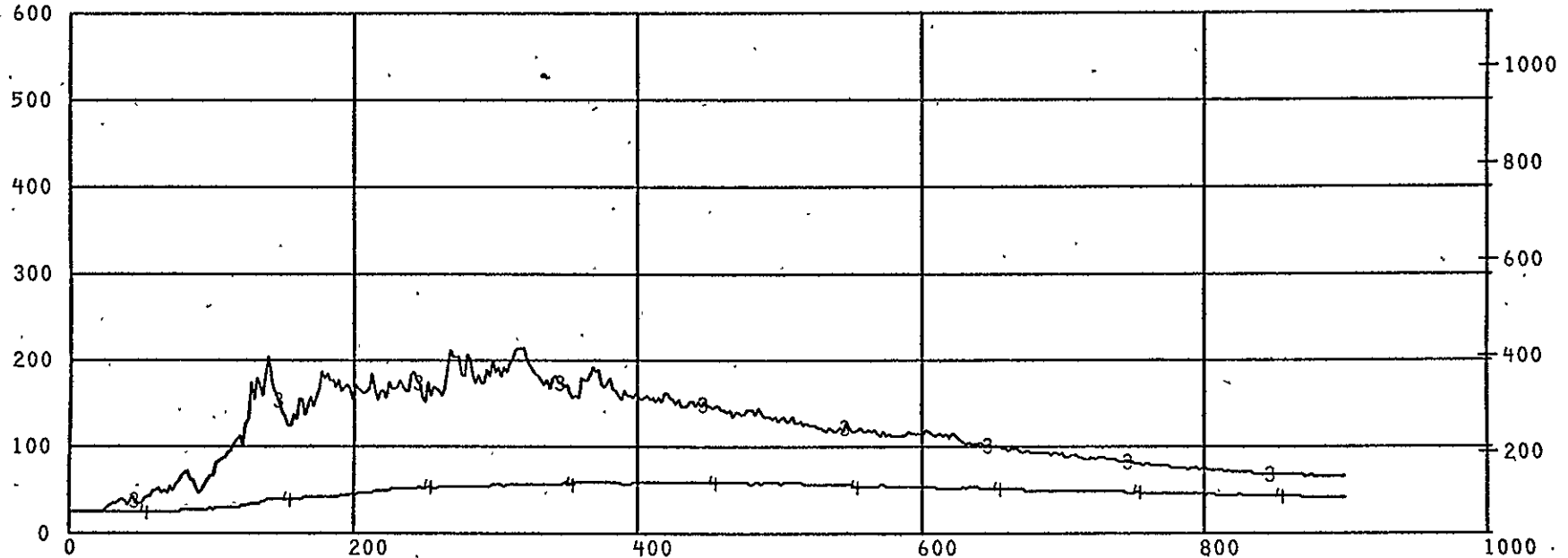
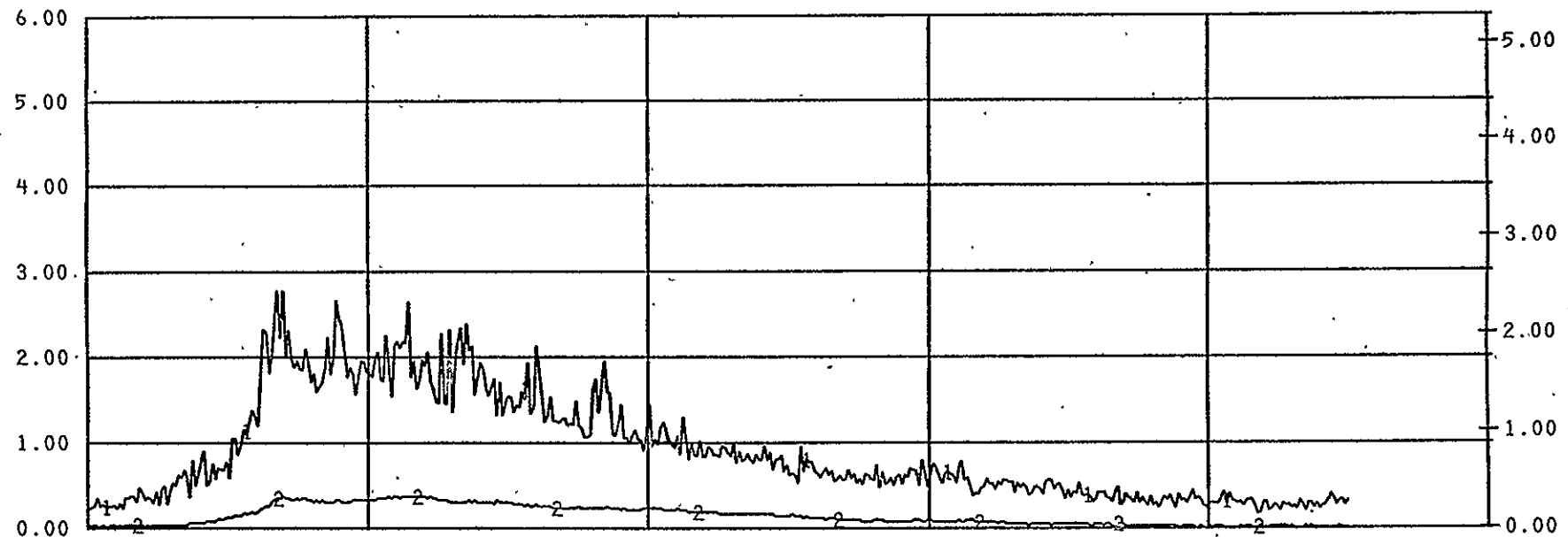
CHANNEL ASGN.
098

TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYI
IN-H2O A6

236



MEAS. NUMBER	CHANNEL ASGN.
\$ C1	
\$ C2	
\$ TC19	139
\$ TC20	120

TITLE
CALORIMETER OVER FIRE
CALORIMETER

RANGE
0.00 TO 6.00
0.00 TO 6.00
0 TO 600
0 TO 600

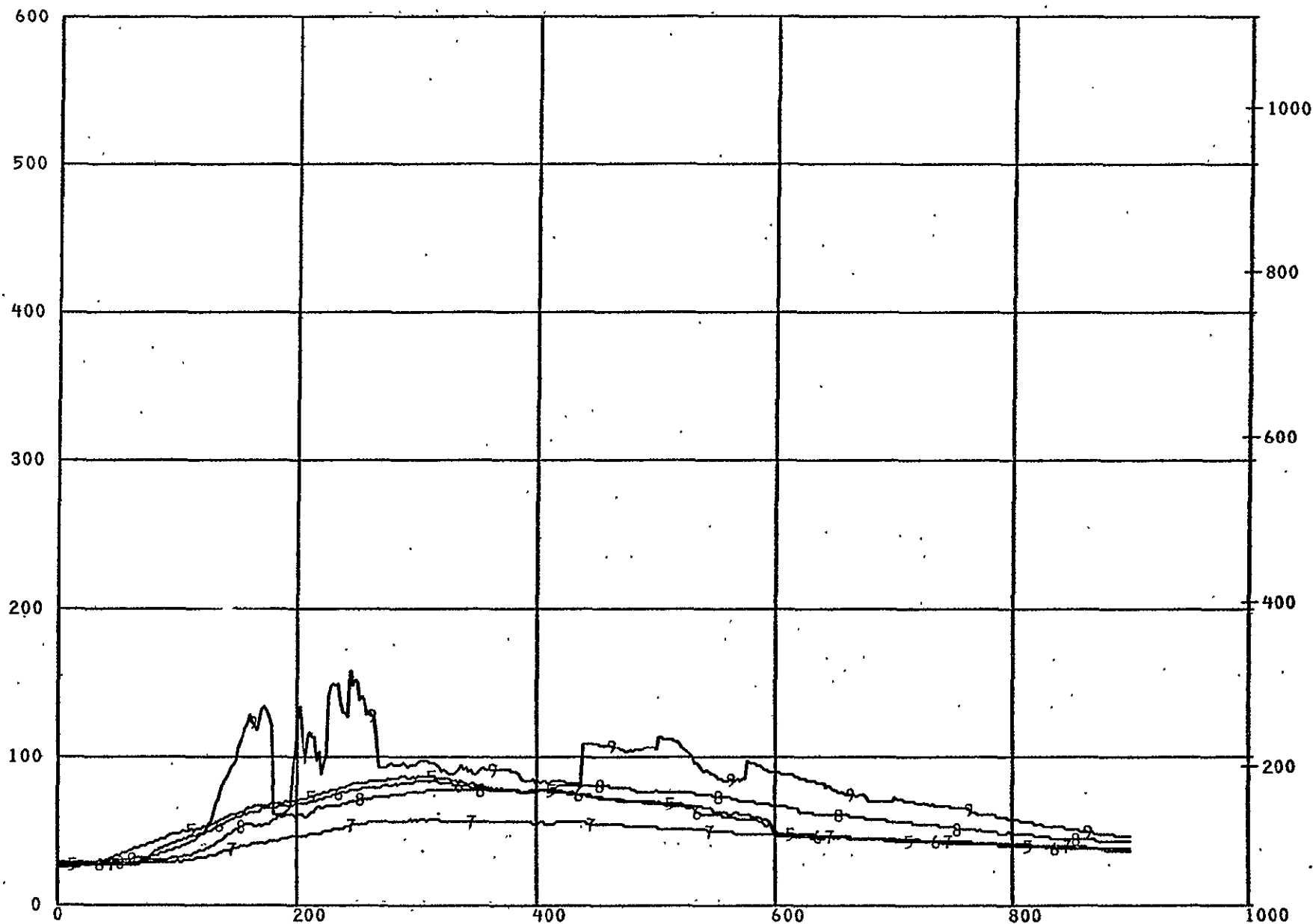
UNITS	GRID-SYM
WATT/CM2	A1
WATT/CM2	A2
DEG C	B3
DEG C	B4

TEST ID 840288 082000

ST11

PLOT NO 2 - 1

REFERENCE TIME 15 29 00.000

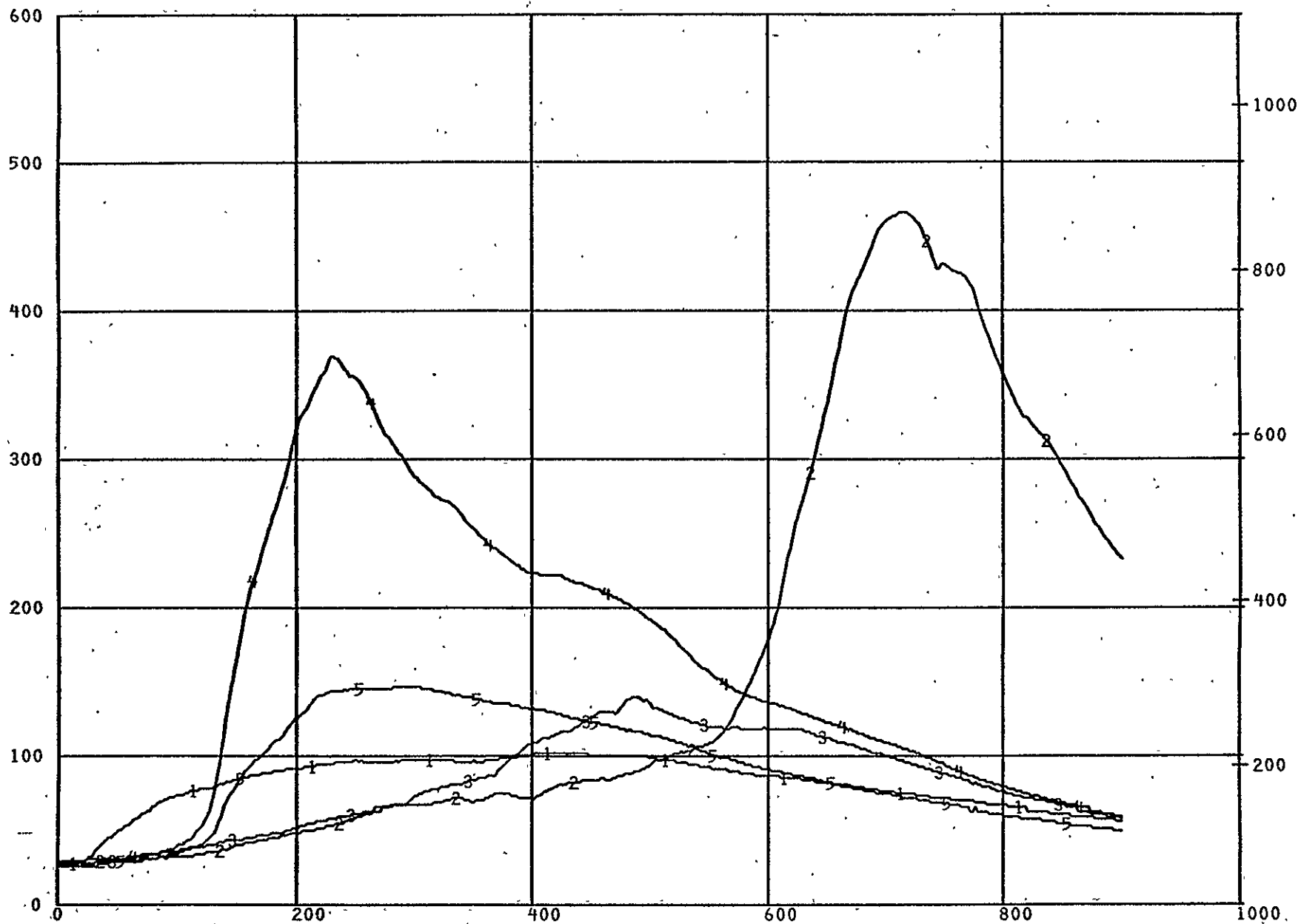


MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS GRID-SYM
DEG C A5
DEG C A6
DEG C A7
DEG C A8
DEG C A9



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

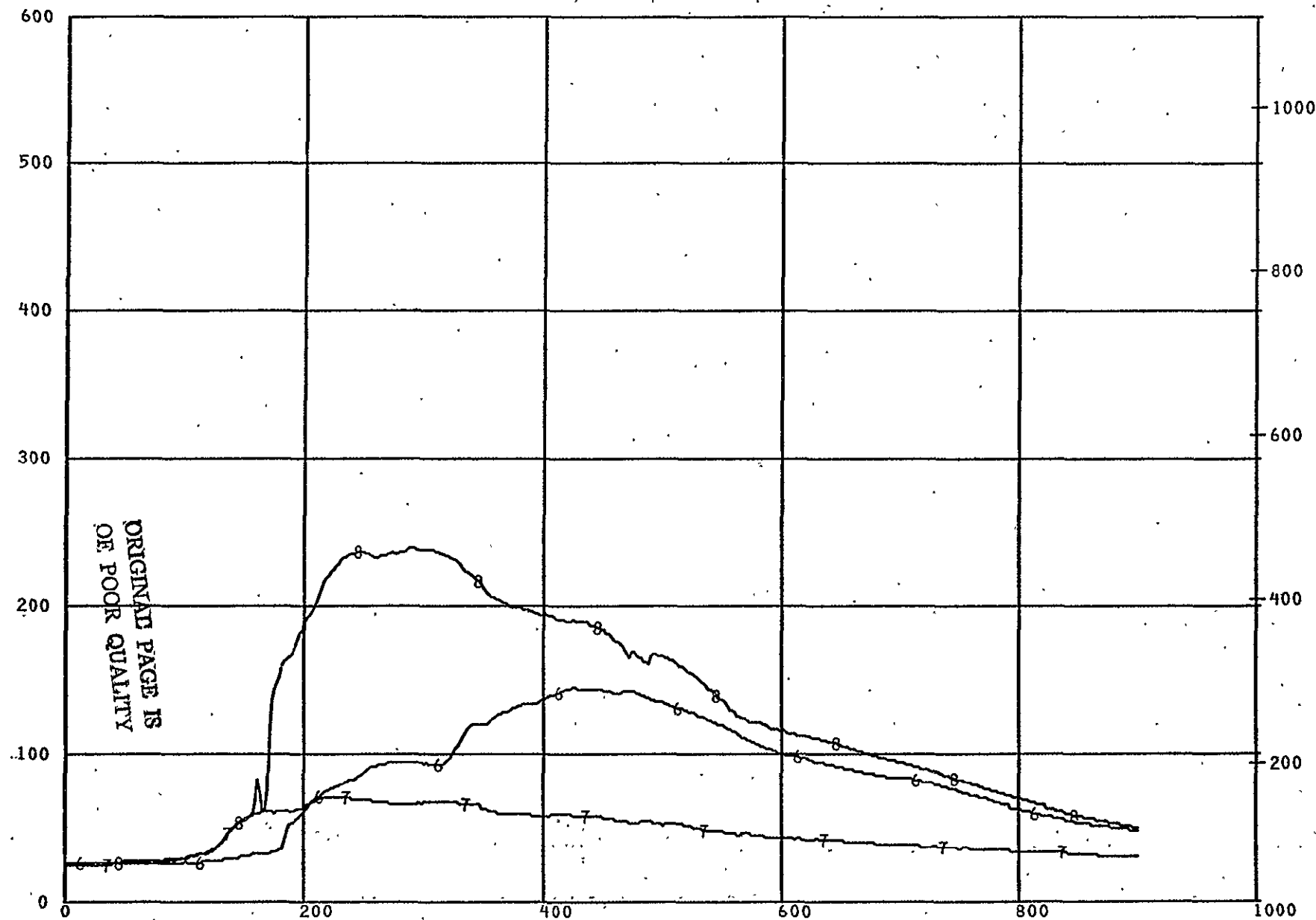
TEST ID 840288 082000

ST11

PLOT NO

4 - 1

REFERENCE TIME 15 29 00.000

D
E
G
F

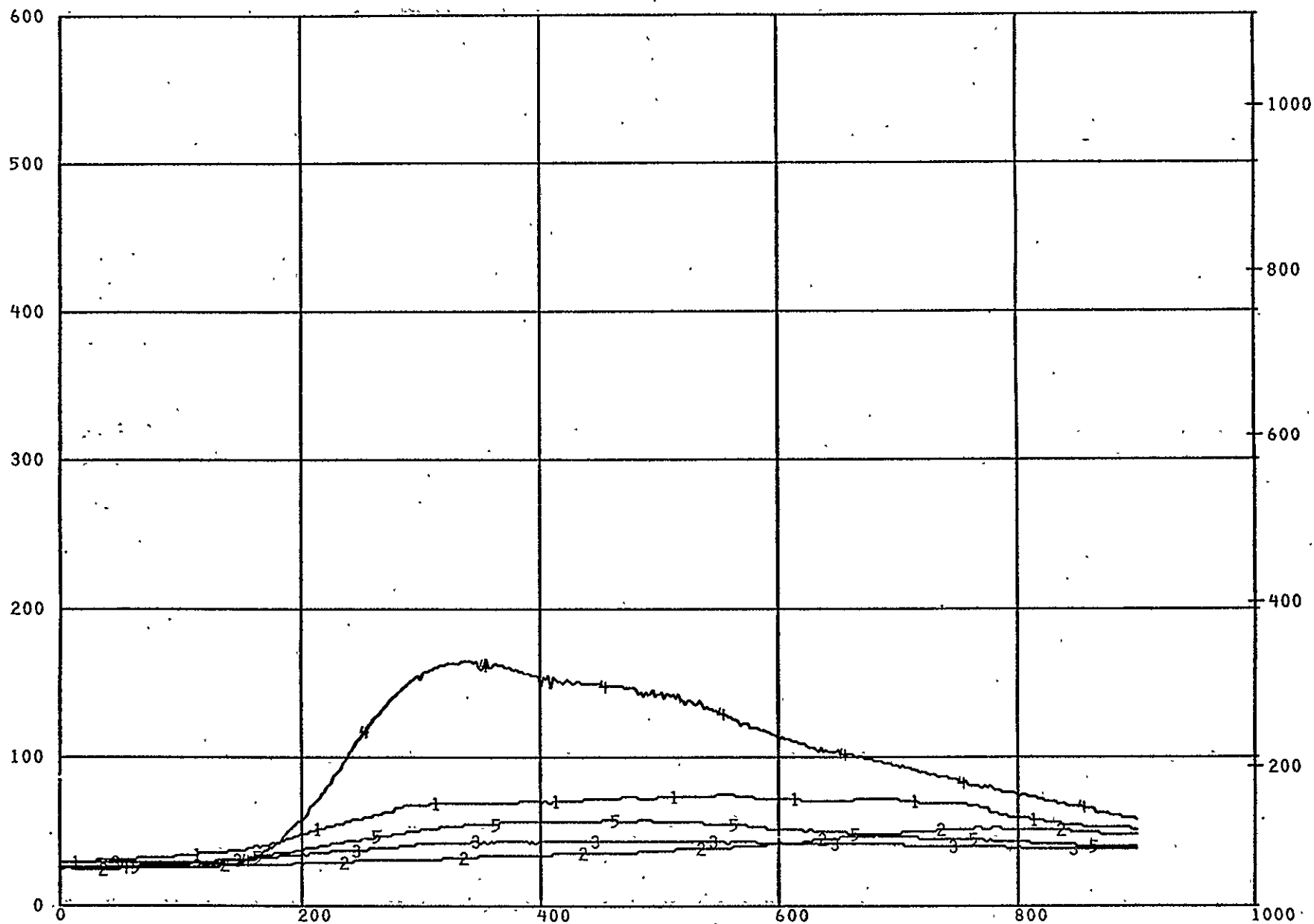
MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

240

D
E
G
F

MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

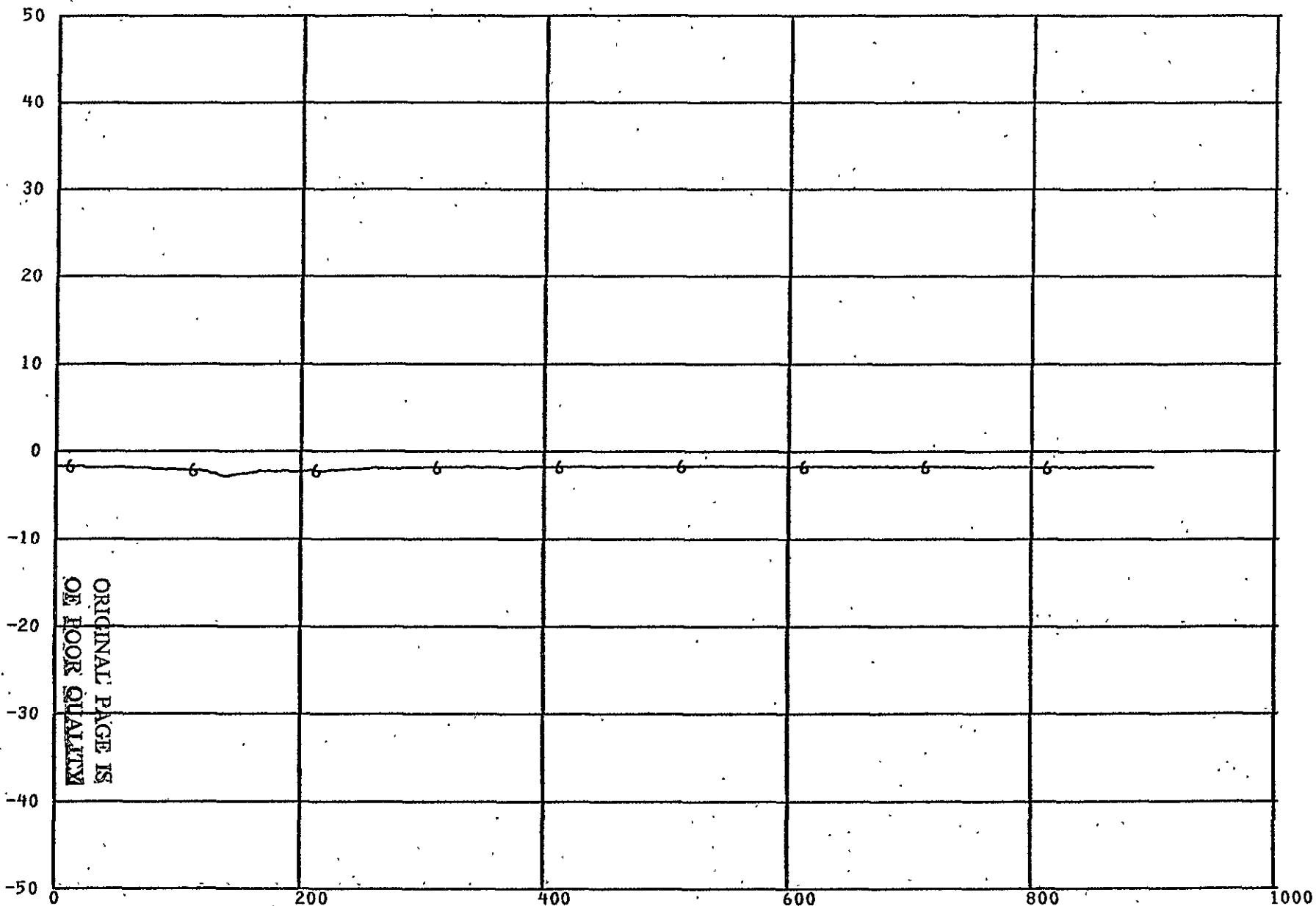
UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 082000

ST11

PLOT NO 6 - 1

REFERENCE TIME 15 29 00.000



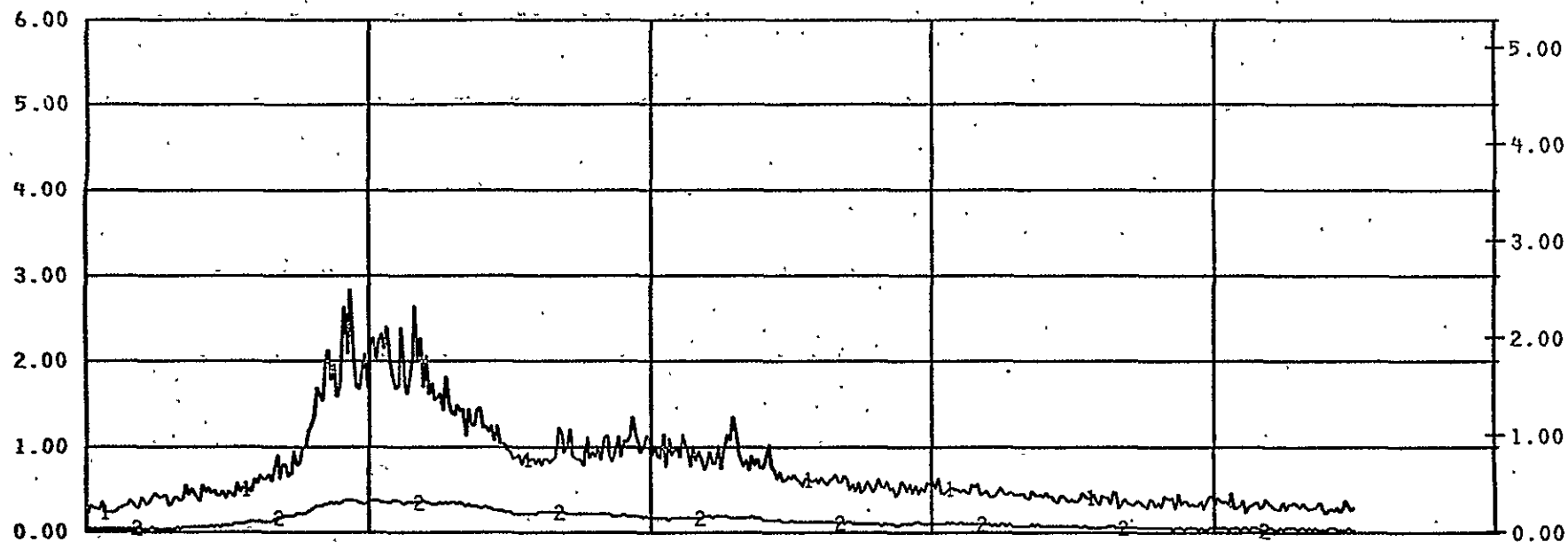
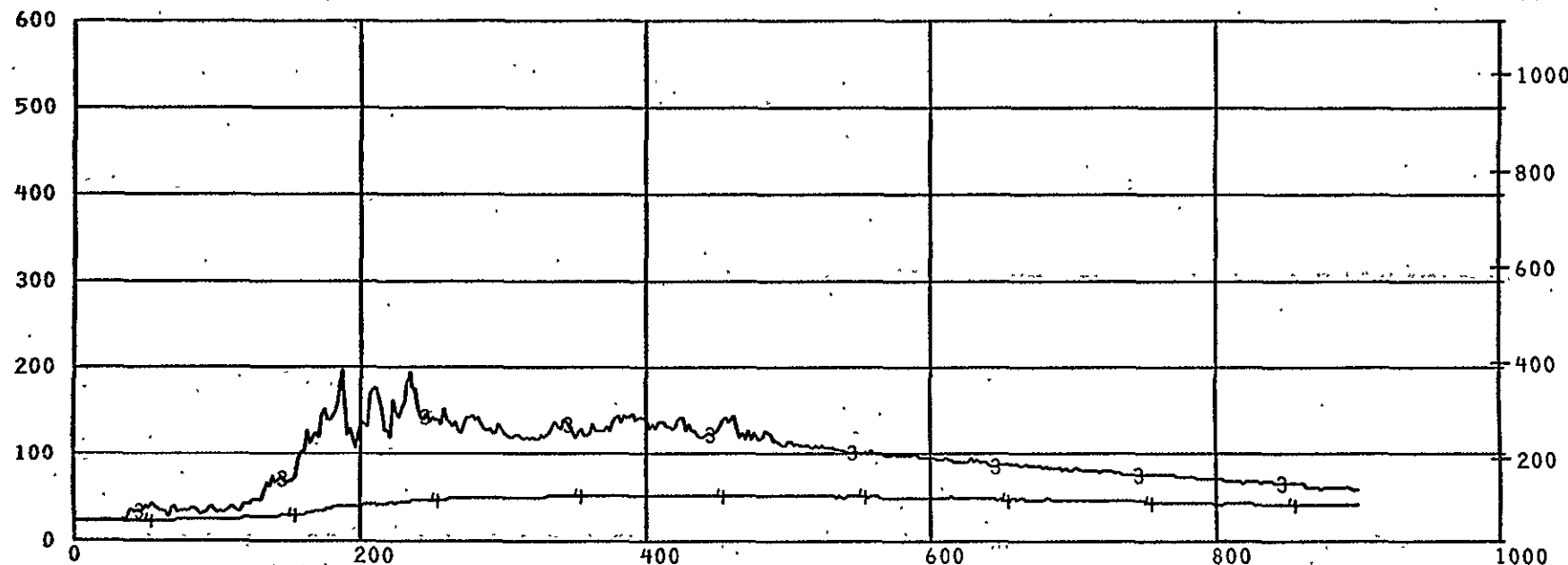
MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

RELATIVE TIME IN SEC
TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
1N-H20 A6

B
T
U
/
F
2
SD
E
G
F

RELATIVE TIME IN SEC

MEAS. NUMBER	CHANNEL ASGN.
\$ C1	
\$ C2	
\$ TC19	139
\$ TC20	120

TITLE
CALORIMETER OVER FIRE
CALORIMETER

RANGE
0.00 TO 6.00
0.00 TO 6.00
0 TO 600
0 TO 600

UNITS	GRID-SYM
WATT/CM2	A1
WATT/CM2	A2
DEG C	B3
DEG C	B4

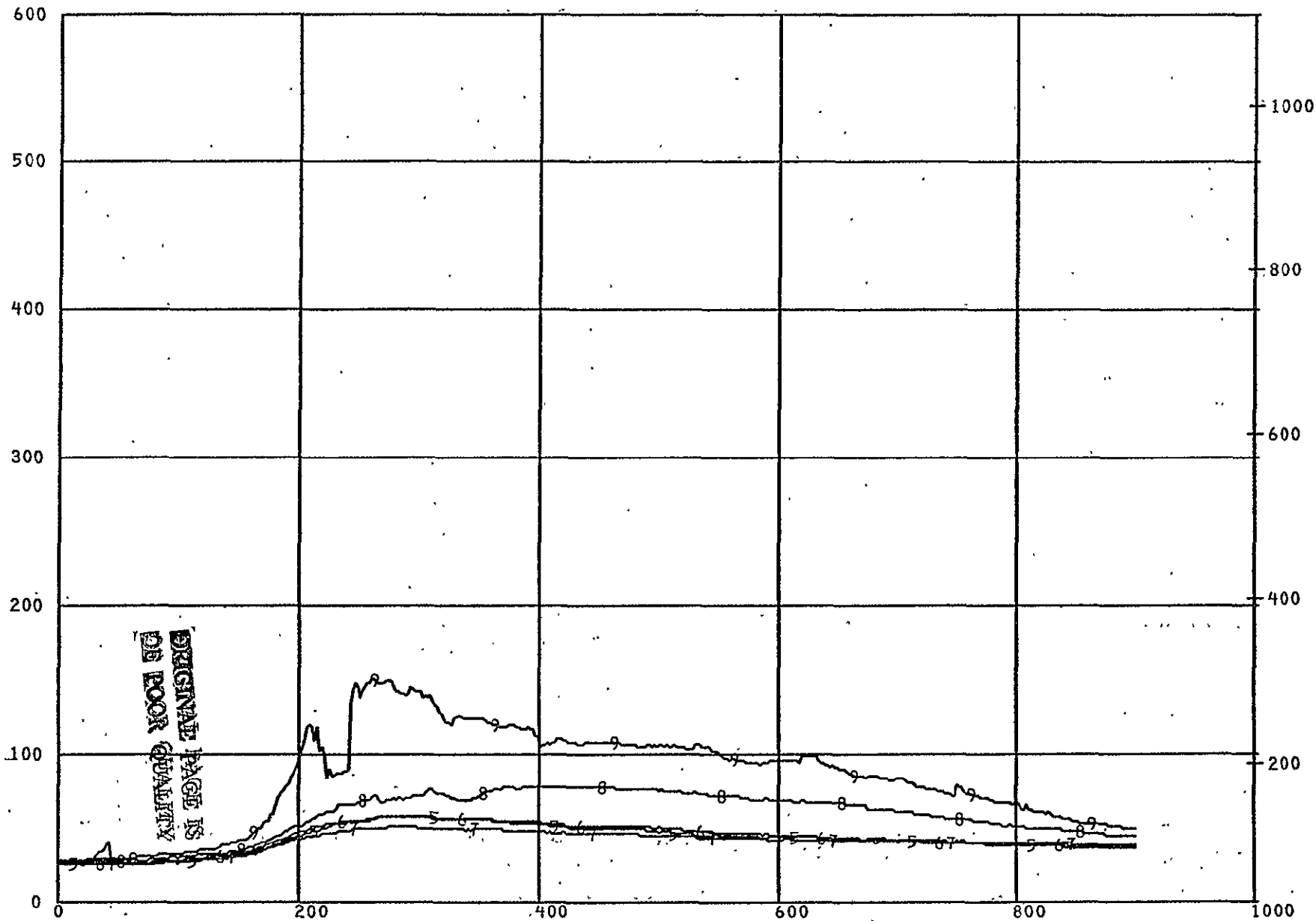
TEST ID 840288 083000

ST12

PLOT NO

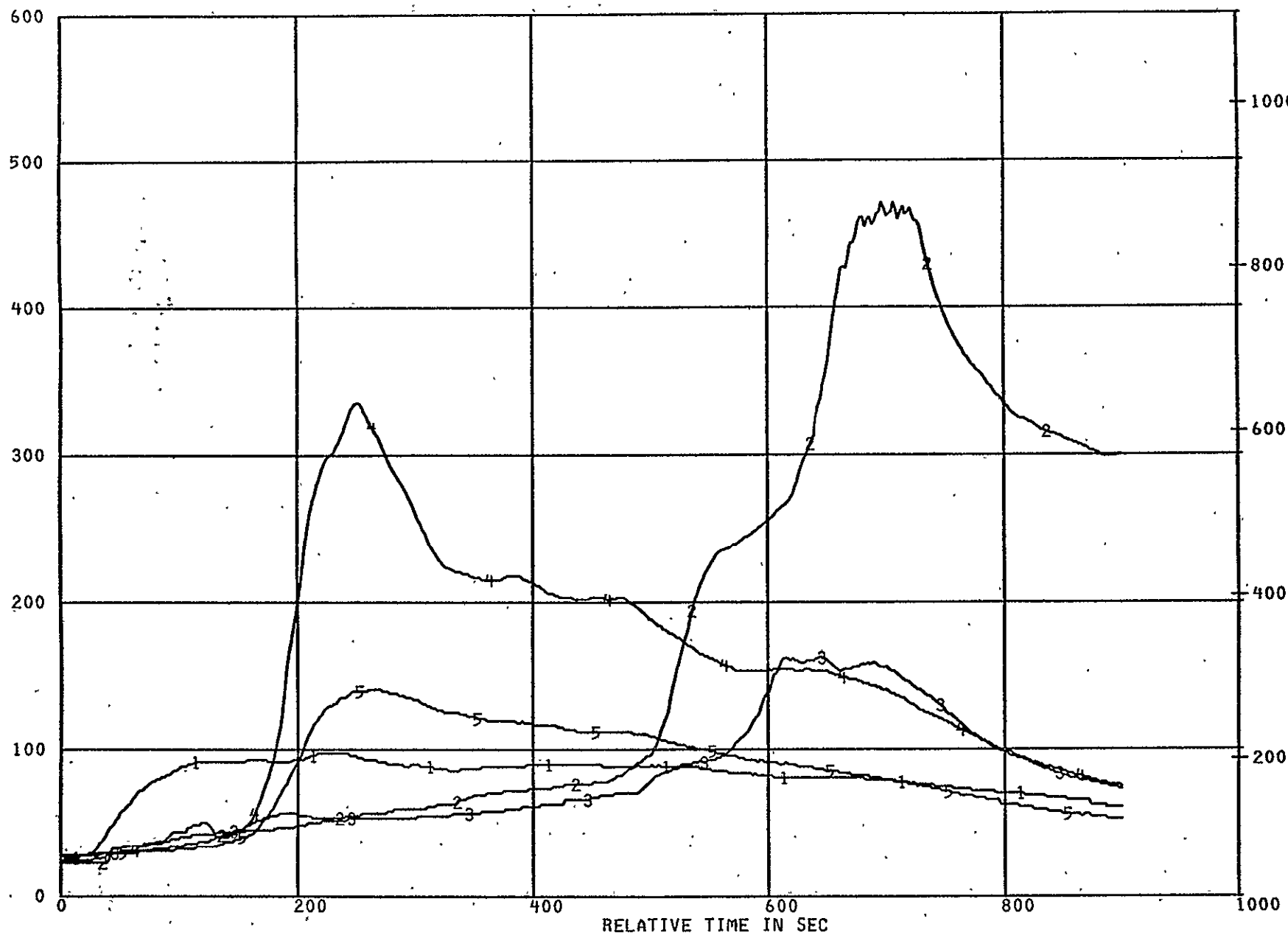
2 - 1

REFERENCE TIME 08 19 00.000

D
E
G
F

MEAS. NUMBER	CHANNEL ASGN.	TITLE	RANGE	UNITS	GRID-SYM
\$ TC05	105		0 TO 600	DEG C	A5
\$ TC06	106		0 TO 600	DEG C	A6
\$ TC07	107		0 TO 600	DEG C	A7
\$ TC12	132		0 TO 600	DEG C	A8
\$ TC13	133		0 TO 600	DEG C	A9

244



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

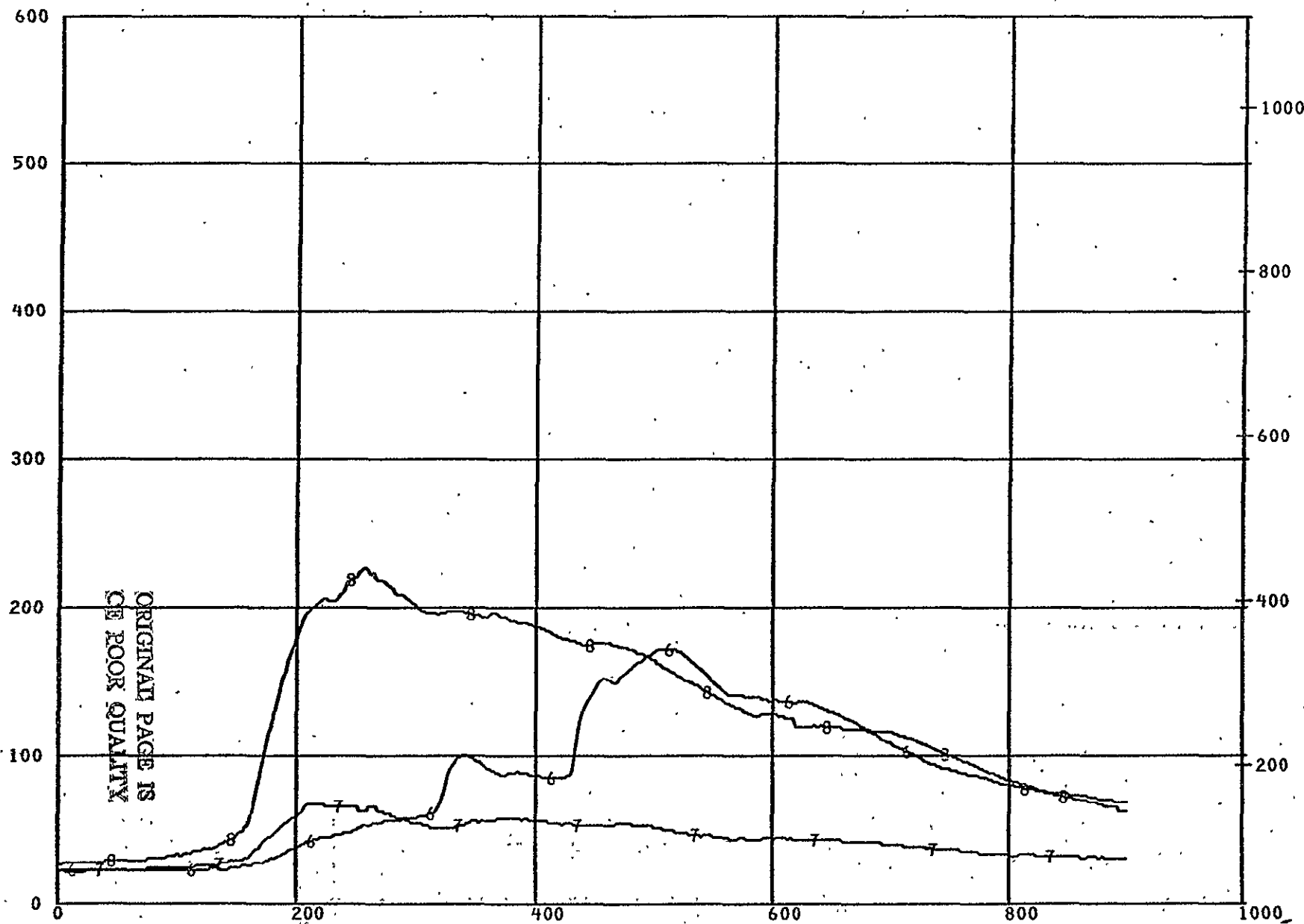
TEST ID 840288 083000

ST12

PLOT NO

4 - 1

REFERENCE TIME 08 19 00.000

D
E
G
F

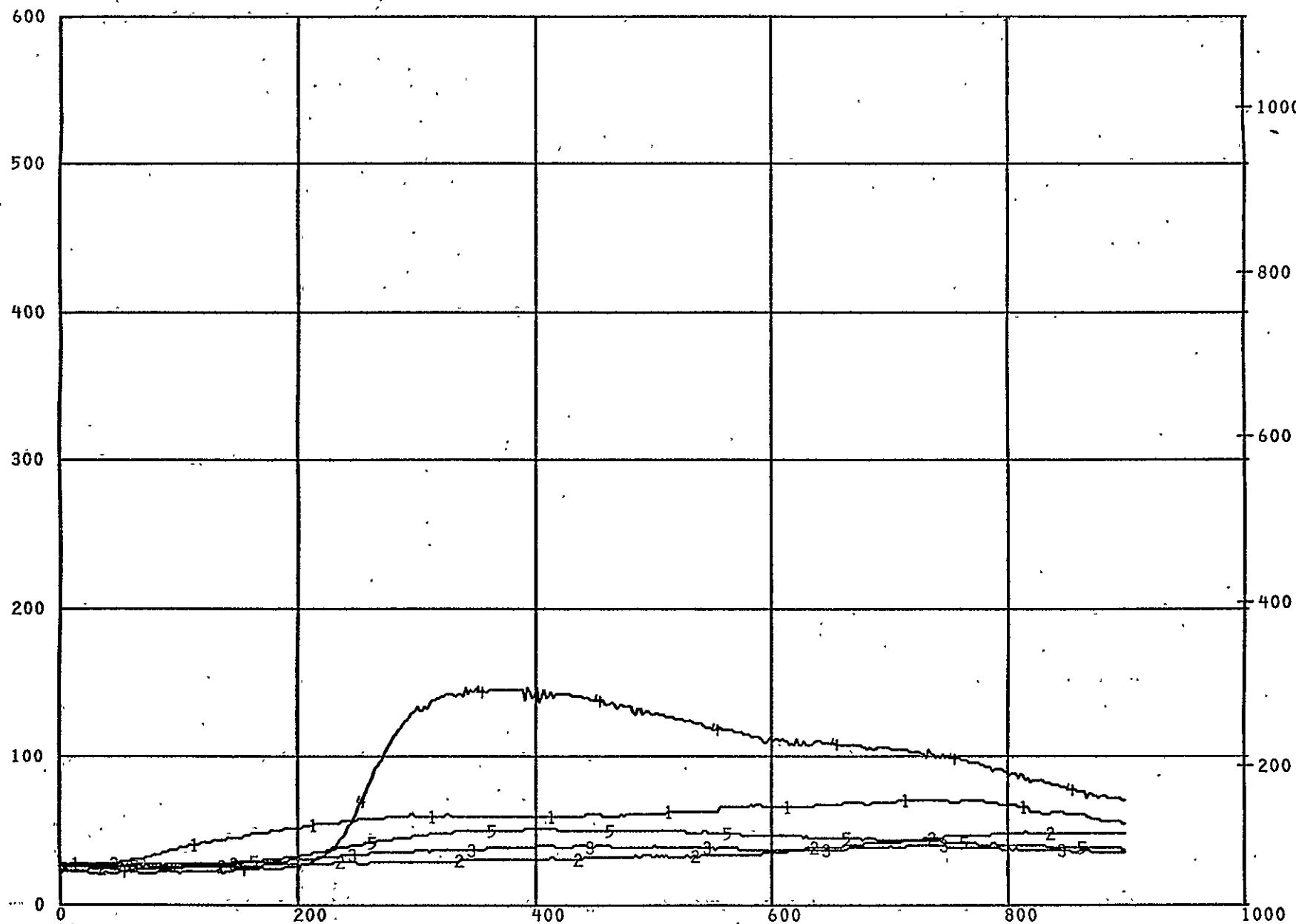
MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

246



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

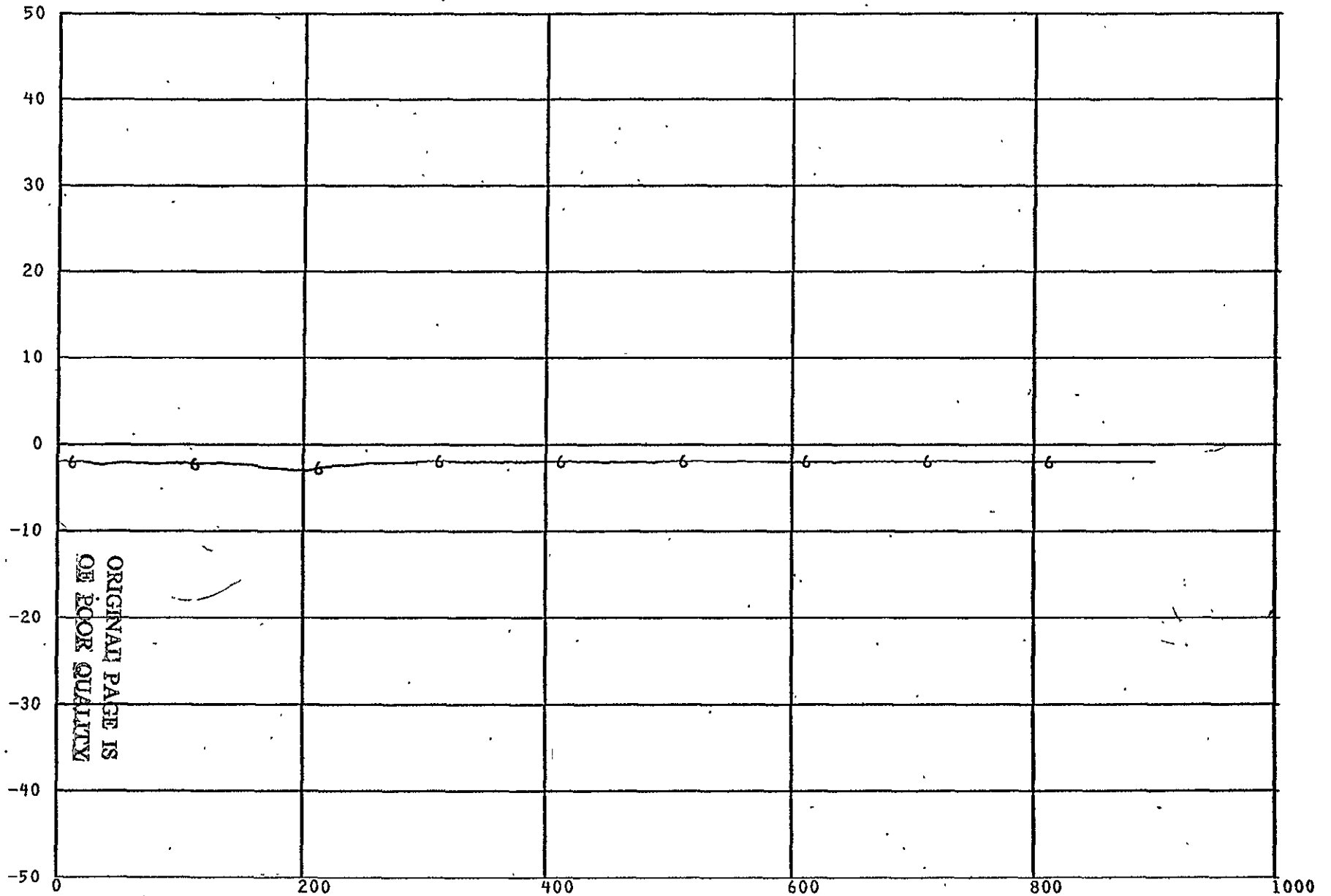
TEST ID 840288 083000

ST12

PLOT NO

6 - 1

REFERENCE TIME 08 19 00.000



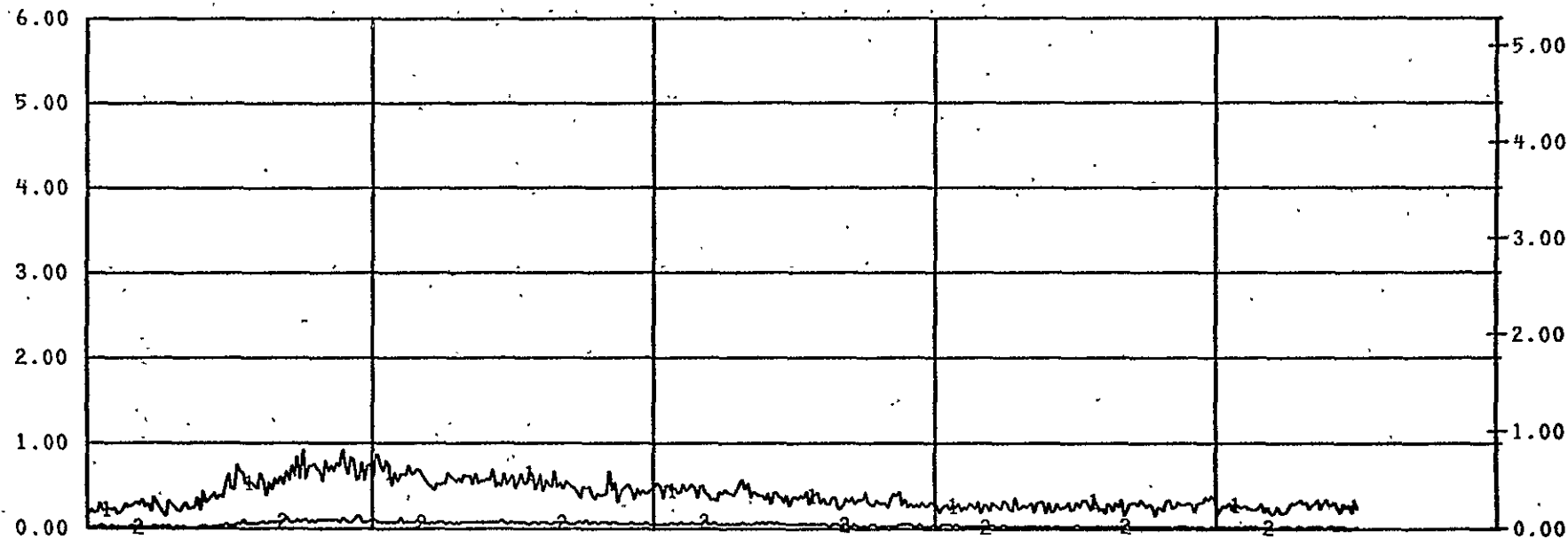
MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

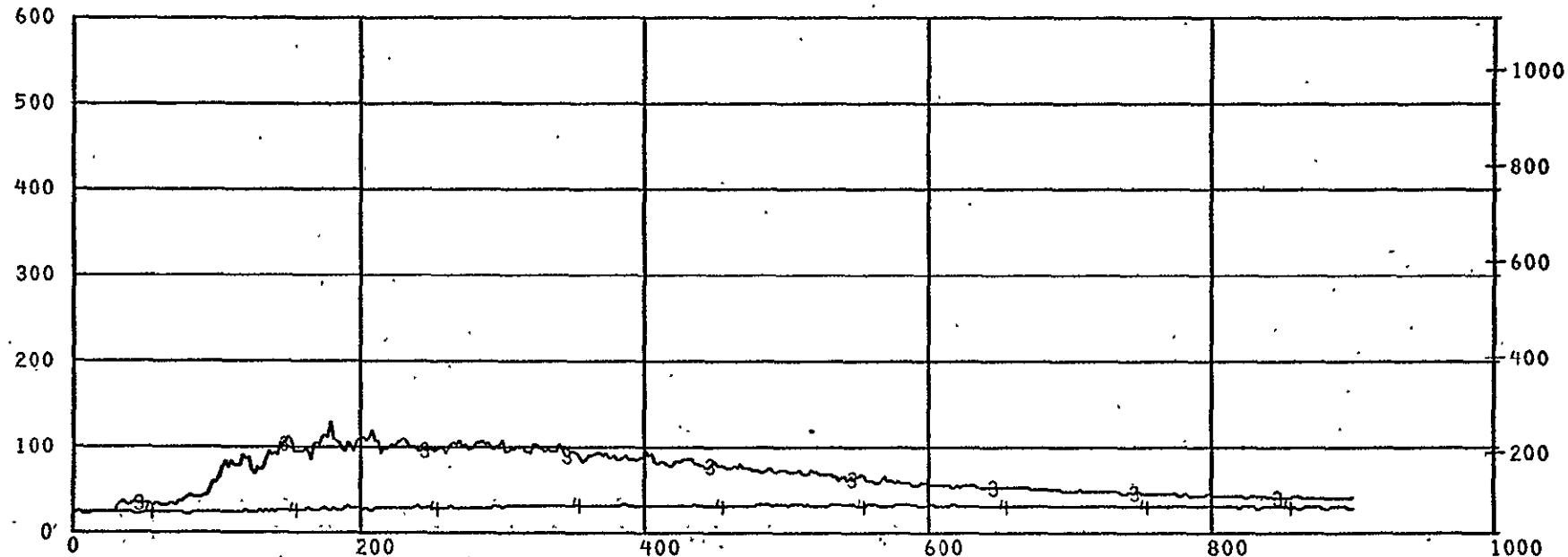
RELATIVE TIME IN SEC
TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

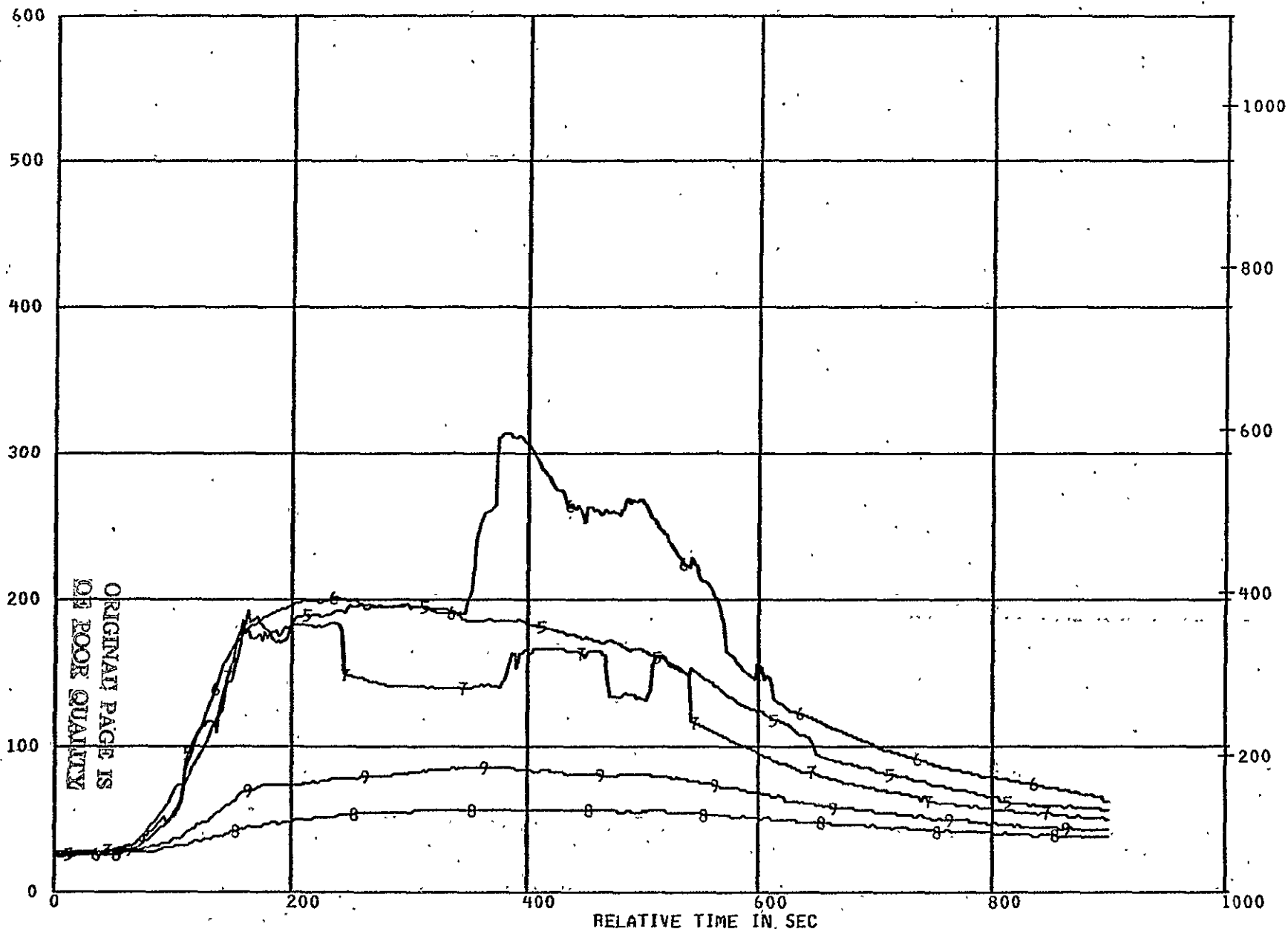
UNITS GRID-SYM
1N-H20 A6

B
T
U
/
F
2
S

248

D
E
G
F

MEAS. NUMBER	CHANNEL ASGN.	TITLE	RANGE	UNITS	GRID-SYM
\$ C1		CALORIMETER OVER FIRE	0.00 TO 6.00	WATT/CM2	A1
\$ C2		CALORIMETER	0.00 TO 6.00	WATT/CM2	A2
\$ TC19	139		0 TO 600	DEG C	B3
\$ TC20	120		0 TO 600	DEG C	B4

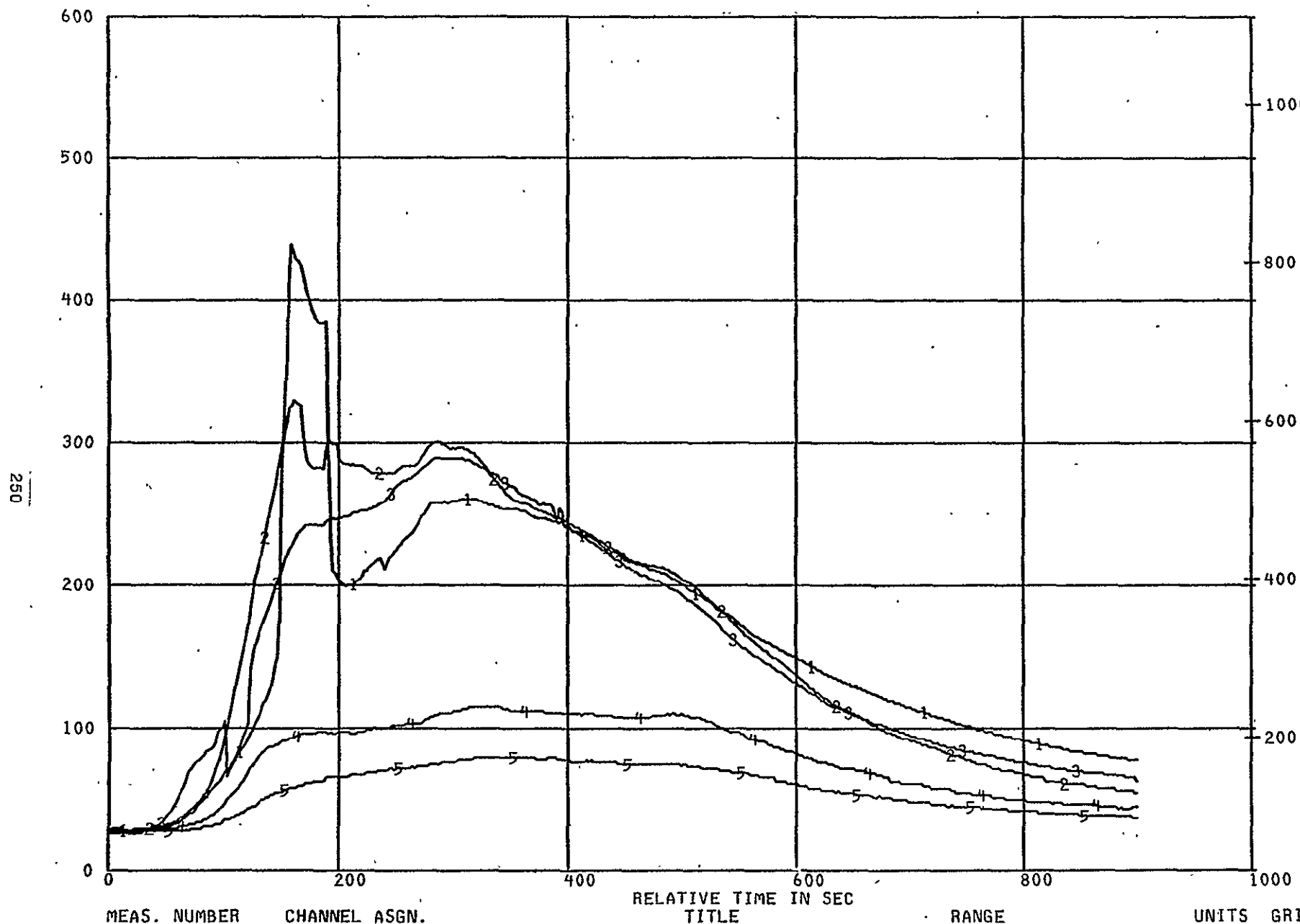


MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS GRID-SYM
DEG C A5
DEG C A6
DEG C A7
DEG C A8
DEG C A9



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

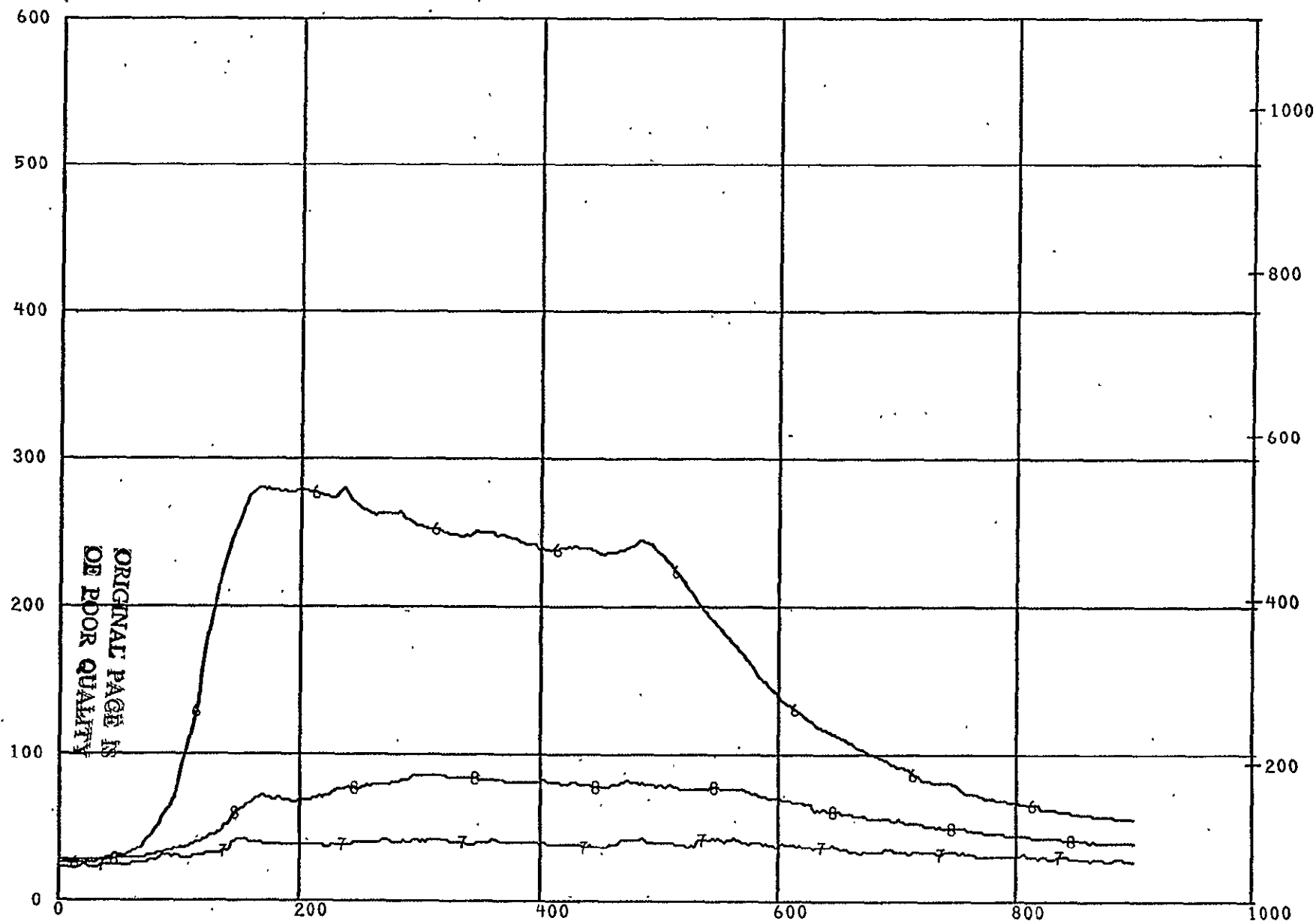
TEST ID 840288 083000

ST13

PLOT NO

4 - 1

REFERENCE TIME 08 50 00.000

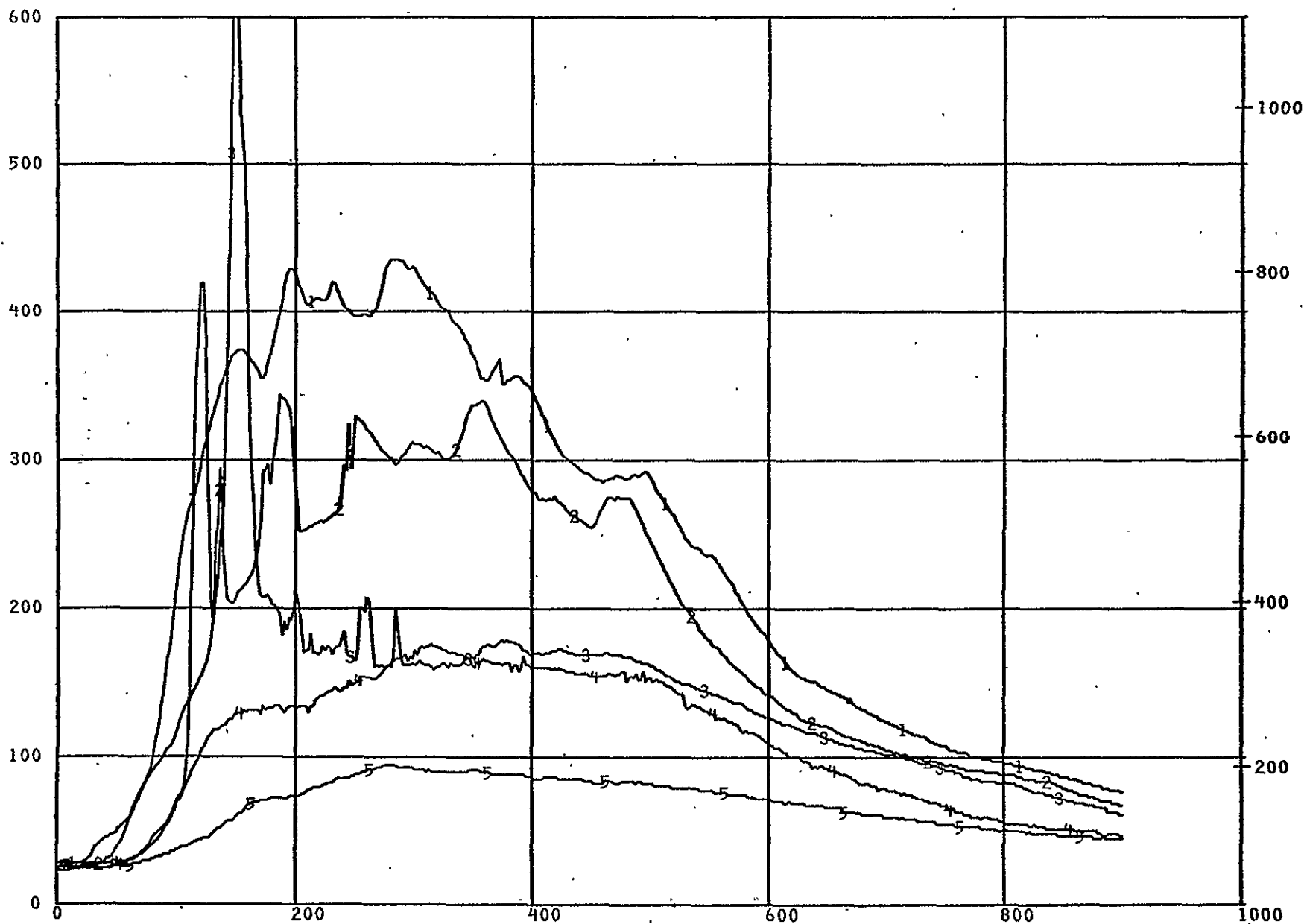
D
E
G
F

MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

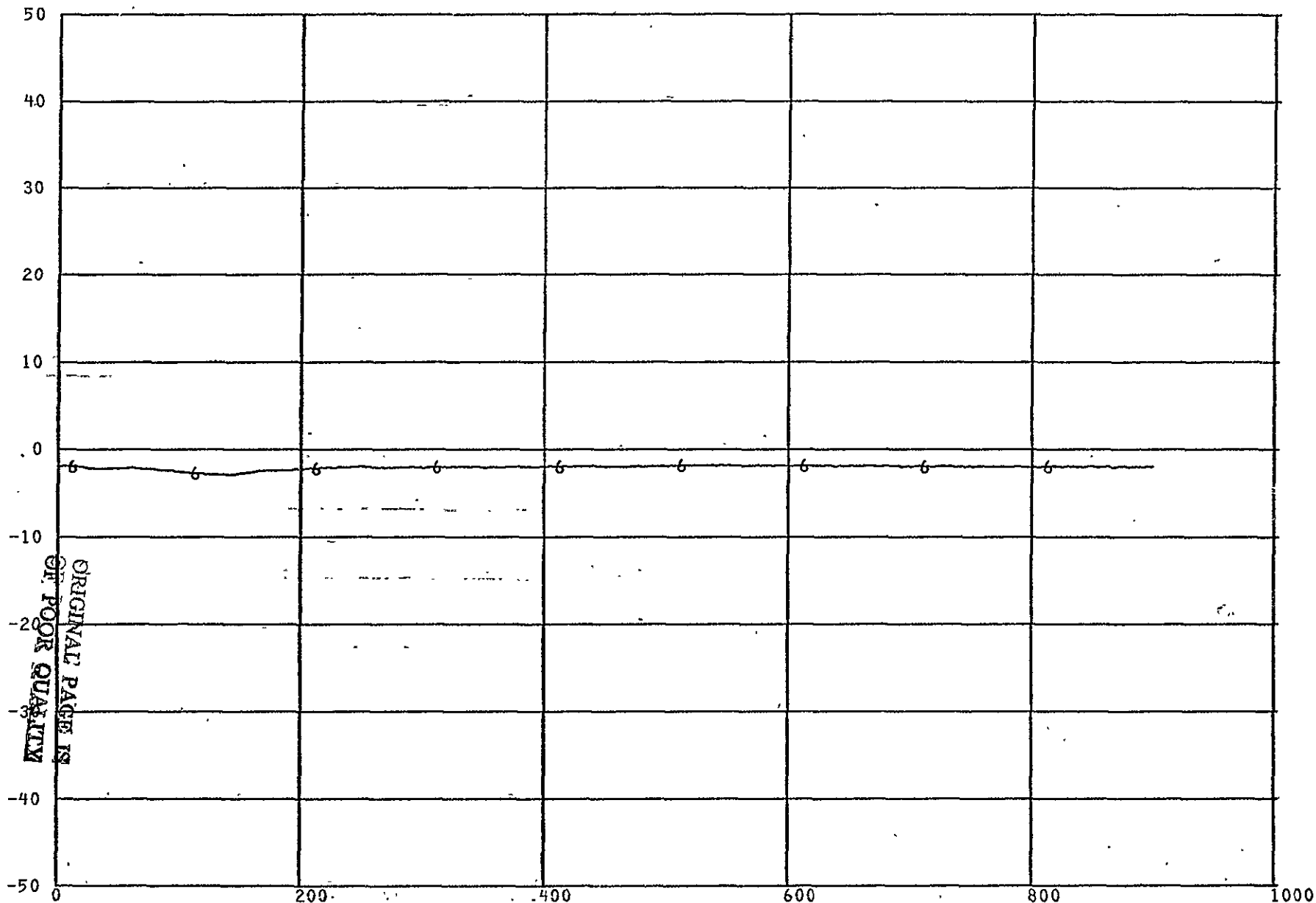
TEST ID 840288 083000

ST13

PLOT NO

6 - 1

REFERENCE TIME 08 50 00.000



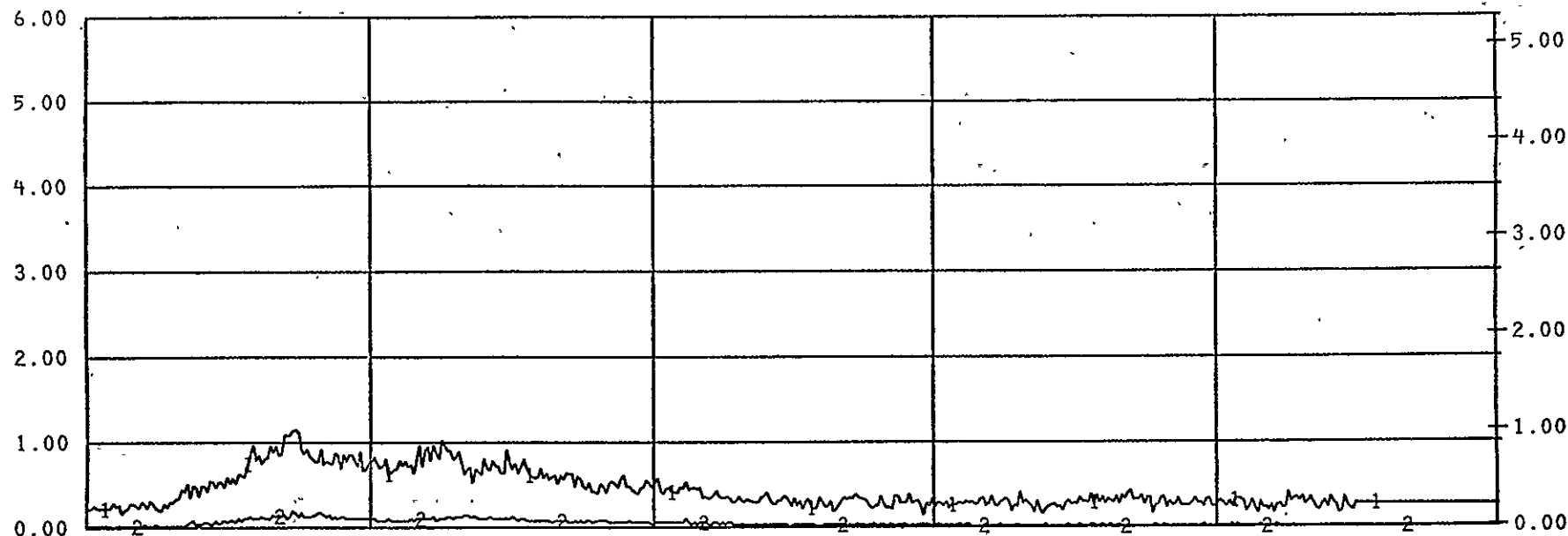
MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

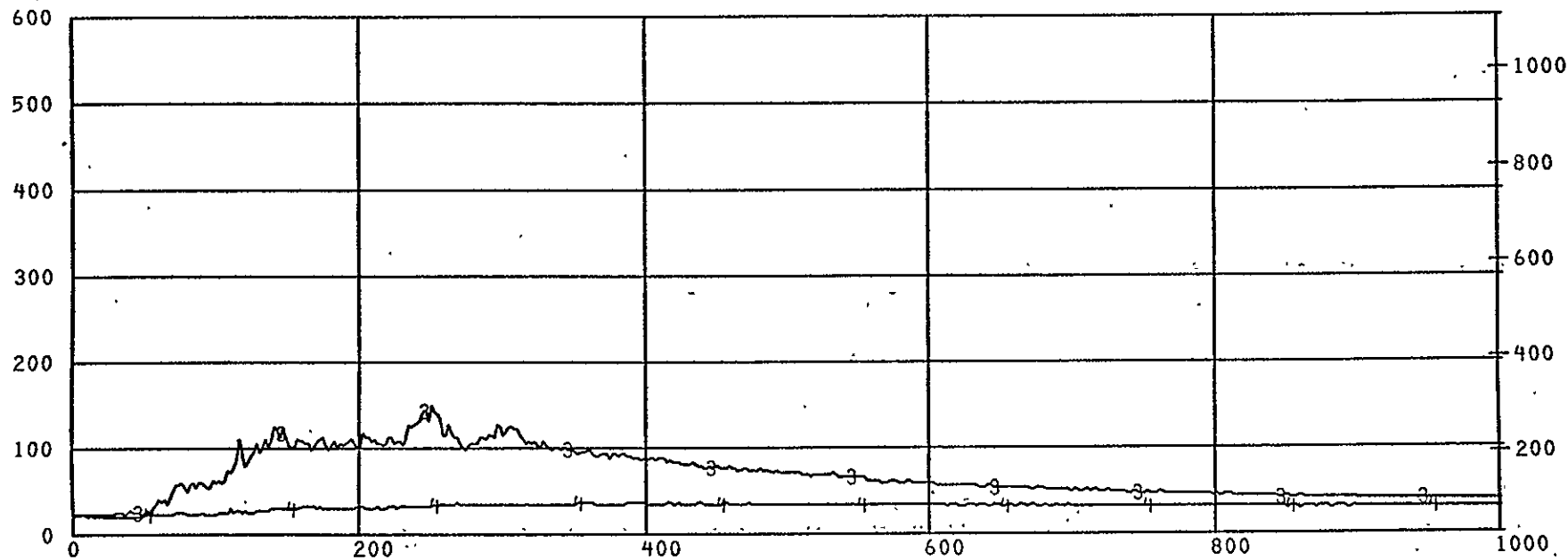
TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
IN-H2O A6



BTU/F2S



DEG F

254

MEAS. NUMBER	CHANNEL ASGN.	TITLE	RANGE	UNITS	GRID-SYM
\$ C1		CALORIMETER OVER FIRE	0.00 TO 6.00	WATT/CM2	A1
\$ C2		CALORIMETER	0.00 TO 6.00	WATT/CM2	A2
\$ TC19	139		0 TO 600	DEG C	B3
\$ TC20	120		0 TO 600	DEG C	B4

TEST ID 840288 083000

ST14

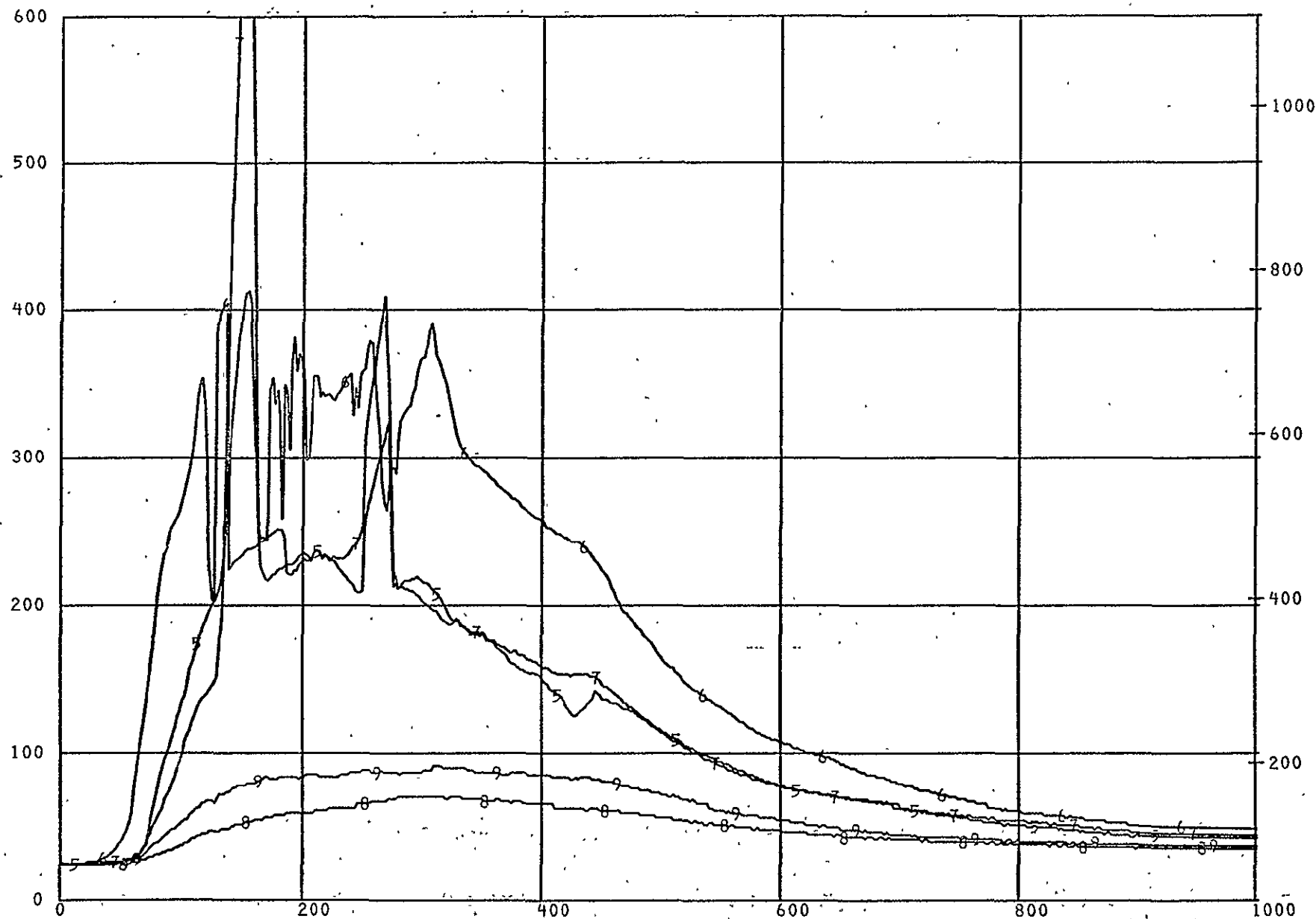
PLOT NO

2 - 1

REFERENCE TIME 09 49 00.000

D
E
G
F

255



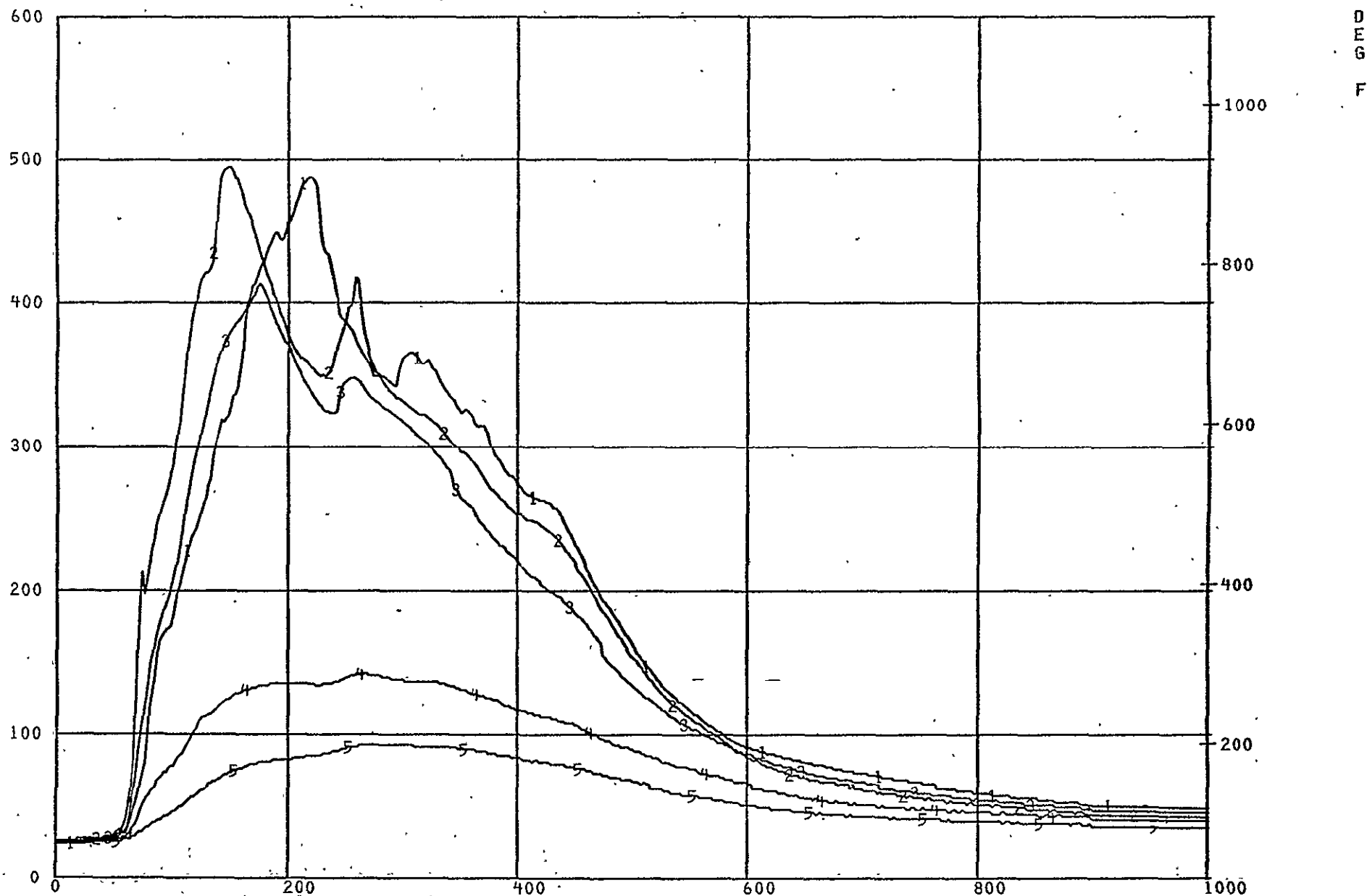
MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

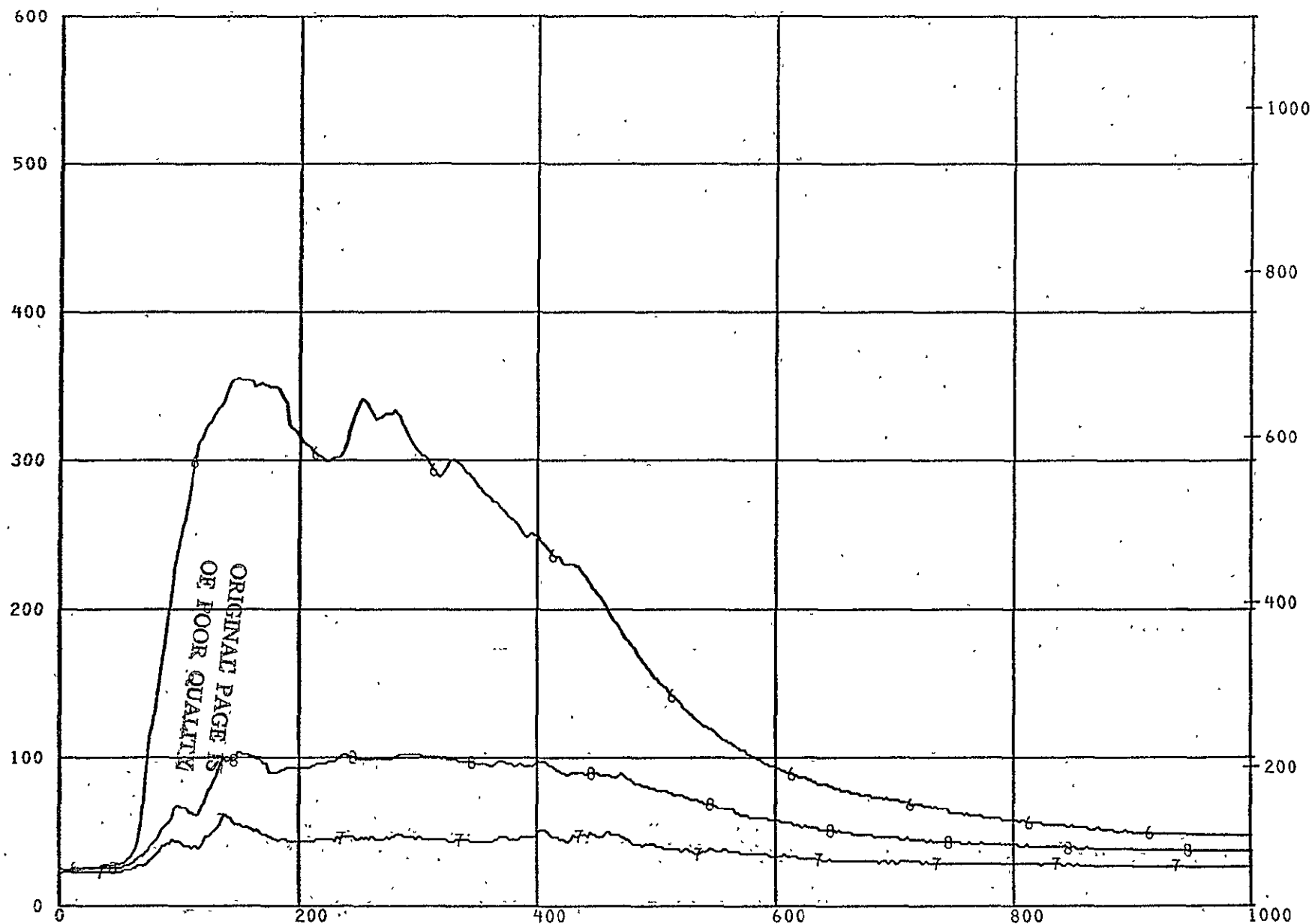
UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

256



MEAS. NUMBER	CHANNEL ASGN.	TITLE	RANGE	UNITS	GRID-SYM
\$ TC01	101		0 TO 600	DEG C	A1
\$ TC02	102		0 TO 600	DEG C	A2
\$ TC03	103		0 TO 600	DEG C	A3
\$ TC09	109		0 TO 600	DEG C	A4
\$ TC08	108		0 TO 600	DEG C	A5

257



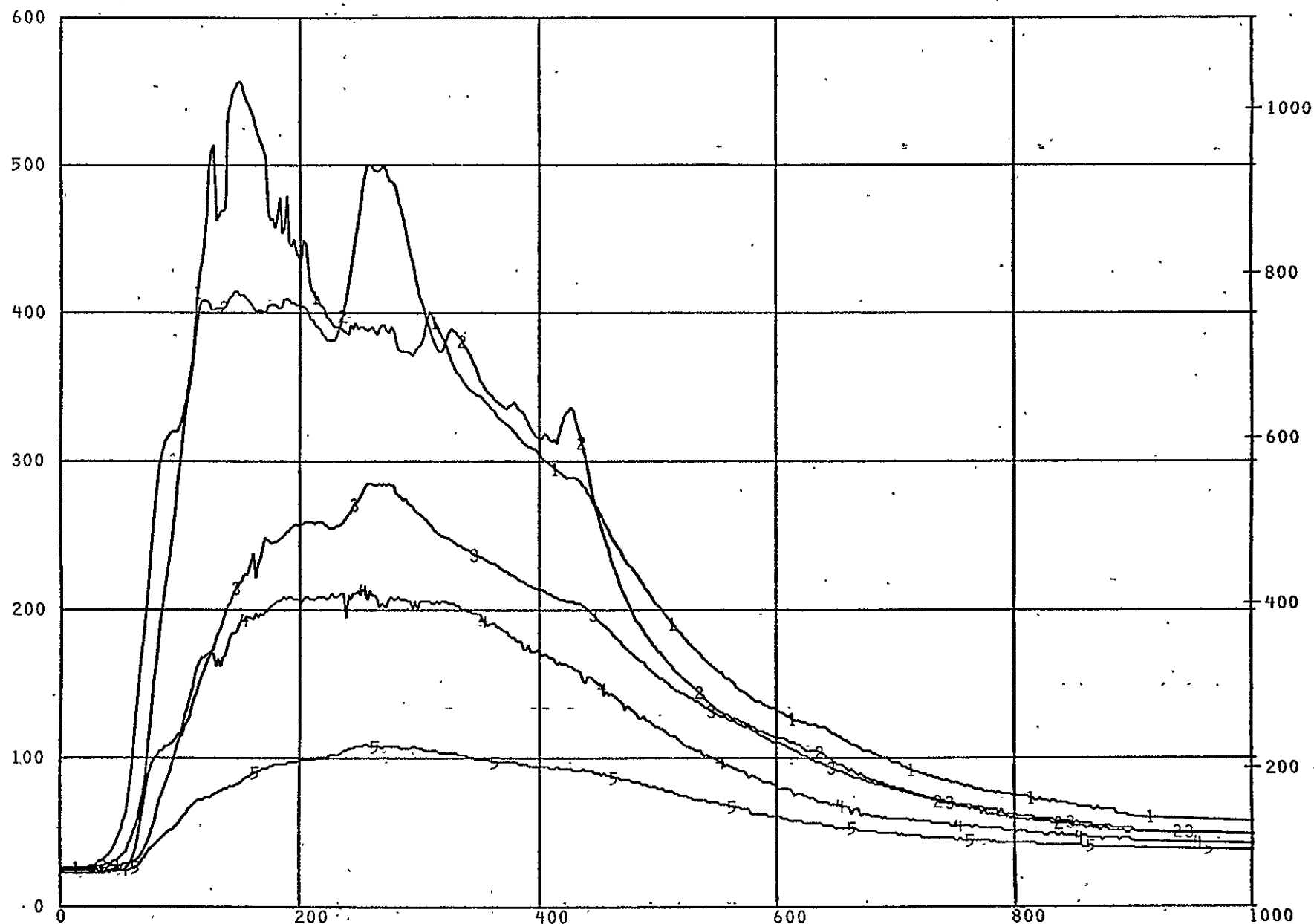
MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

258

D
E
G
F

MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

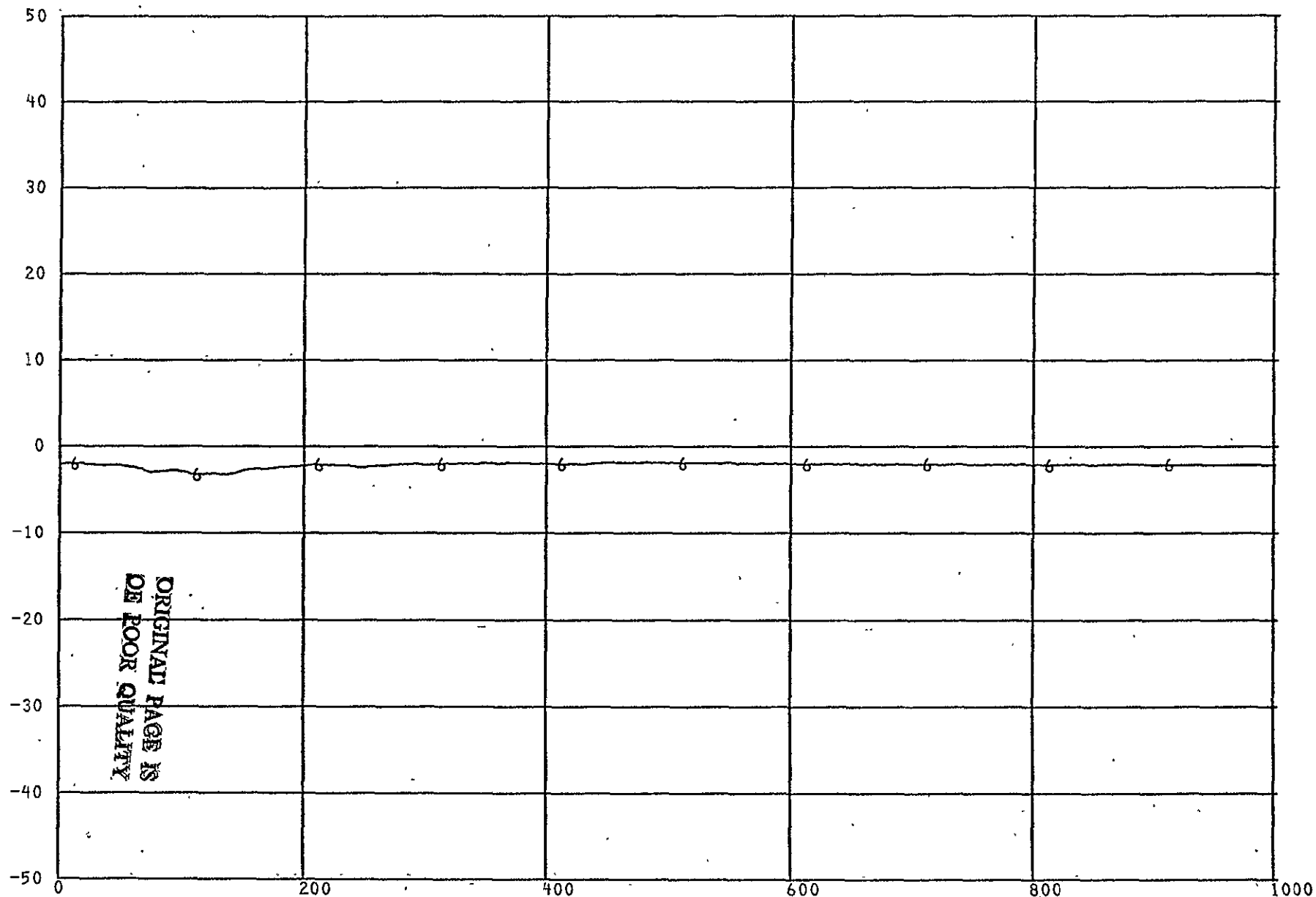
TEST ID 840288 083000

ST14

PLOT NO

6 - 1

REFERENCE TIME 09 49 00.000



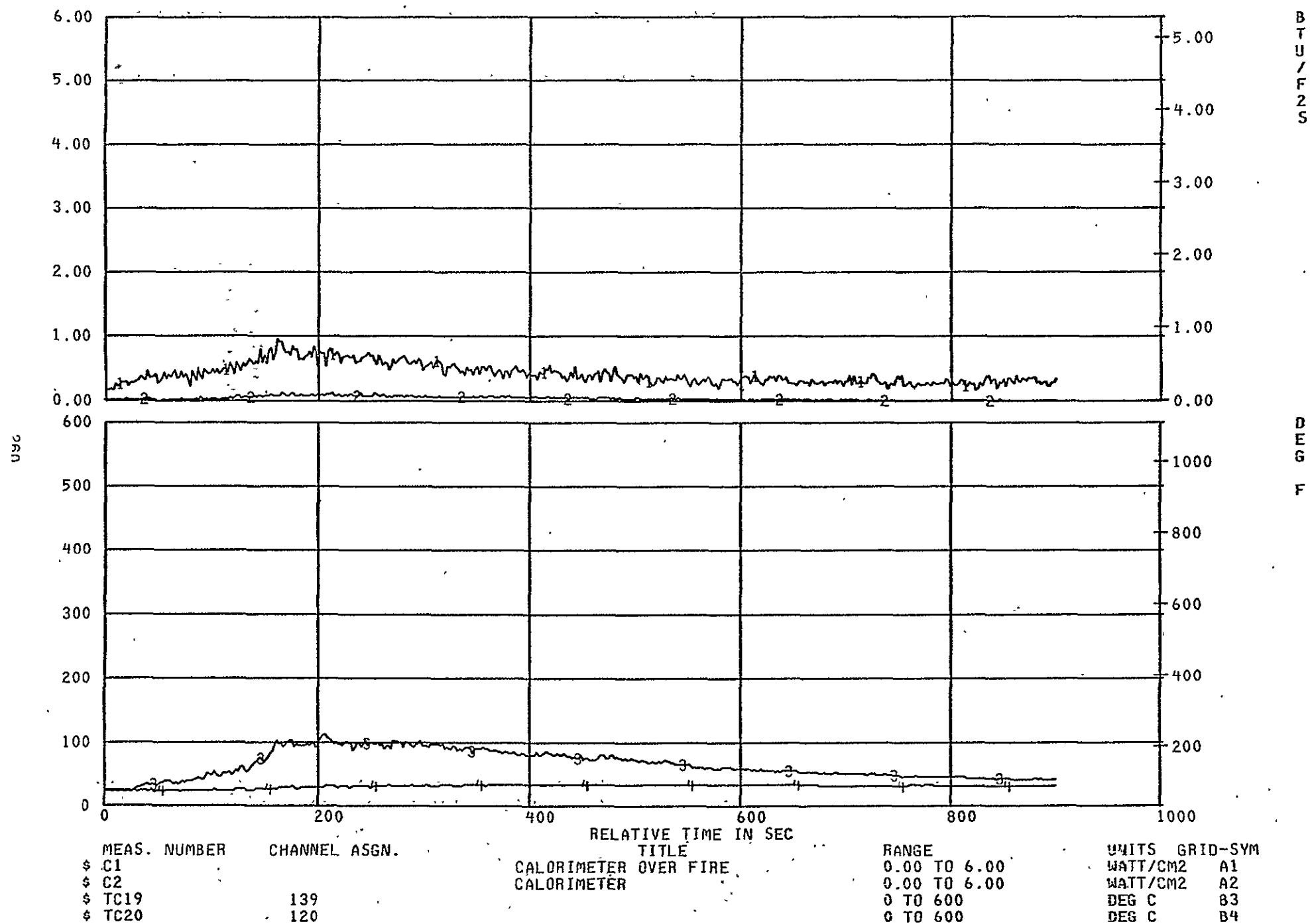
MEAS. NUMBER
PRESS

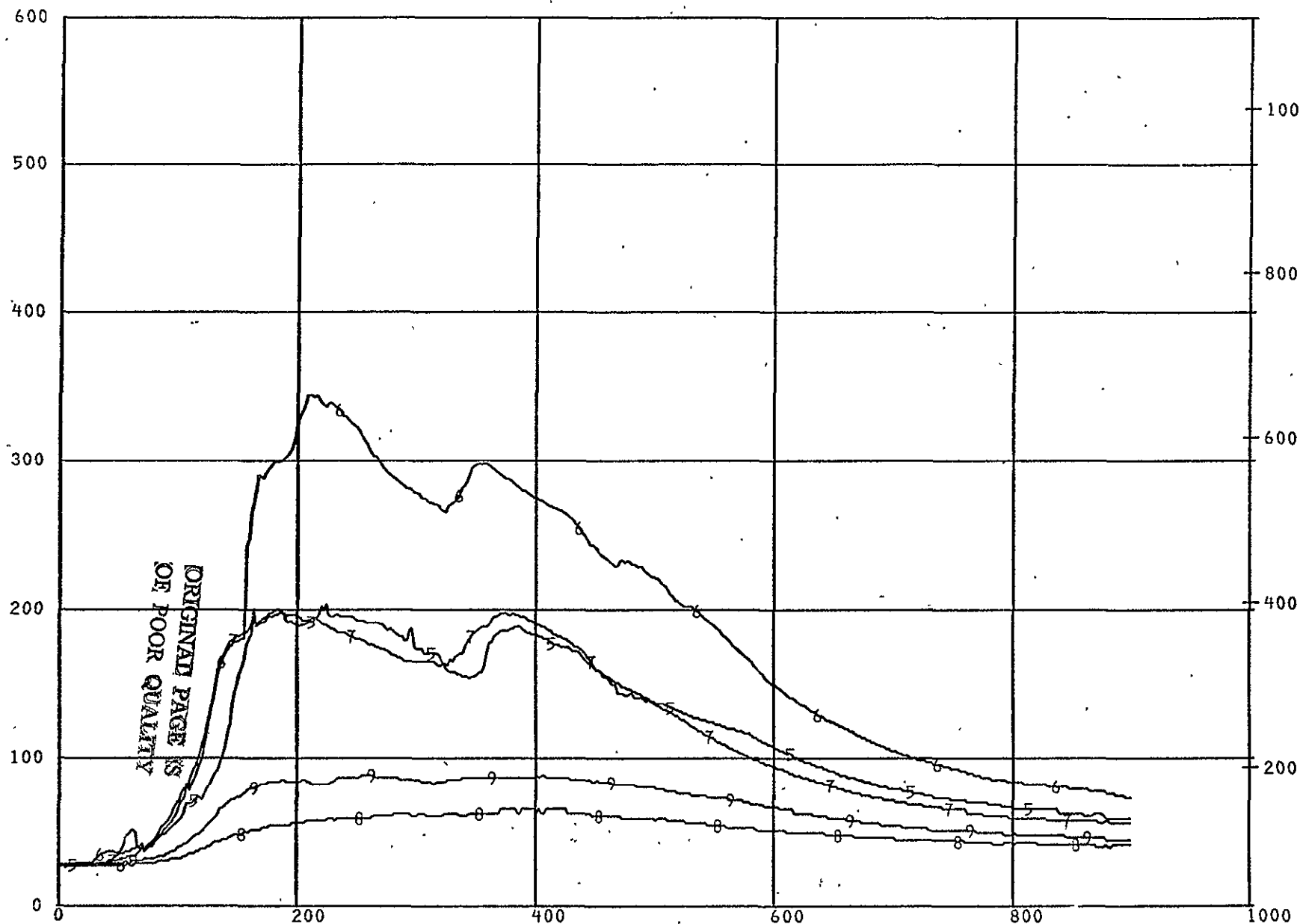
CHANNEL ASGN.
098

TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
IN-H20 A6





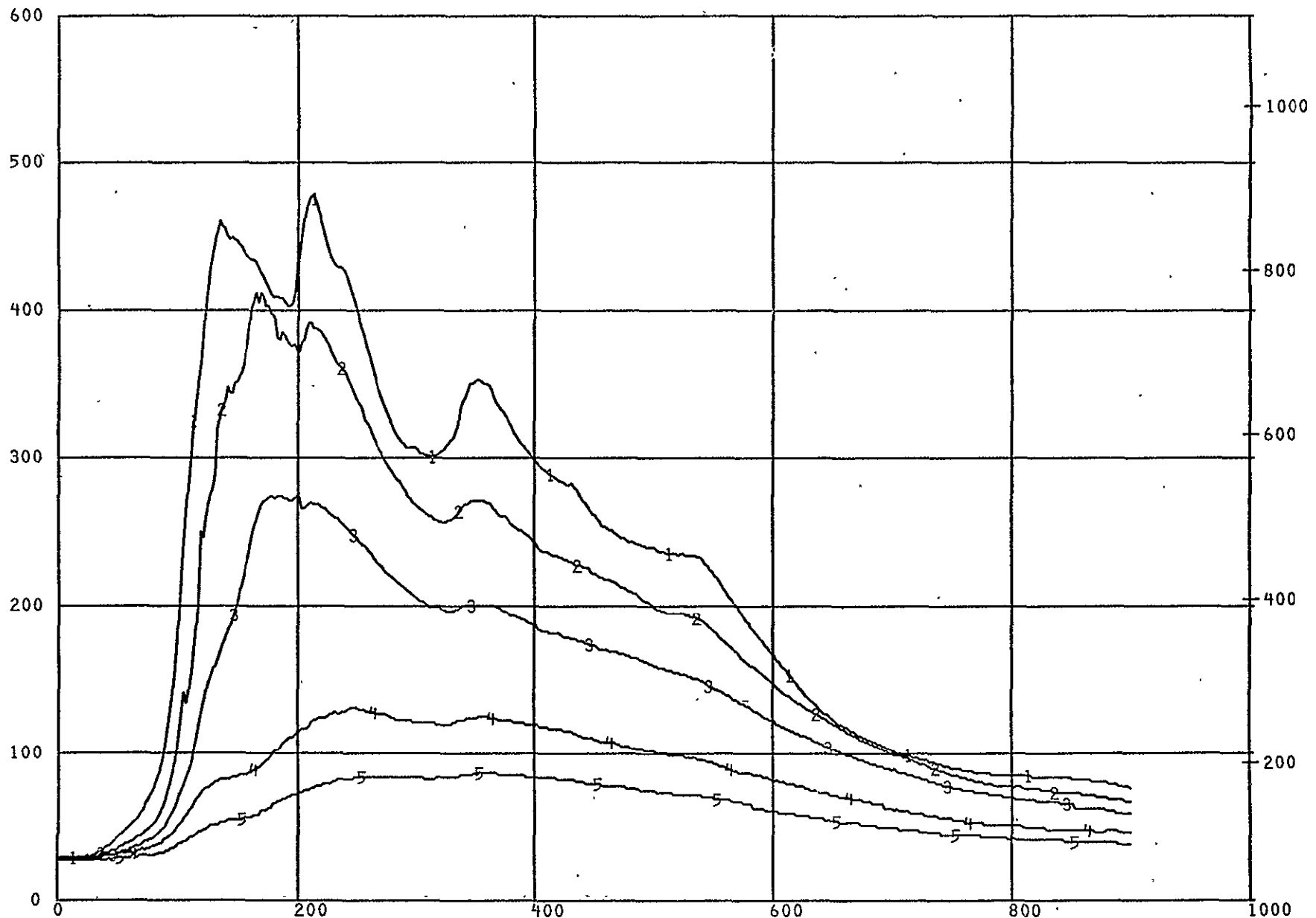
MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

262

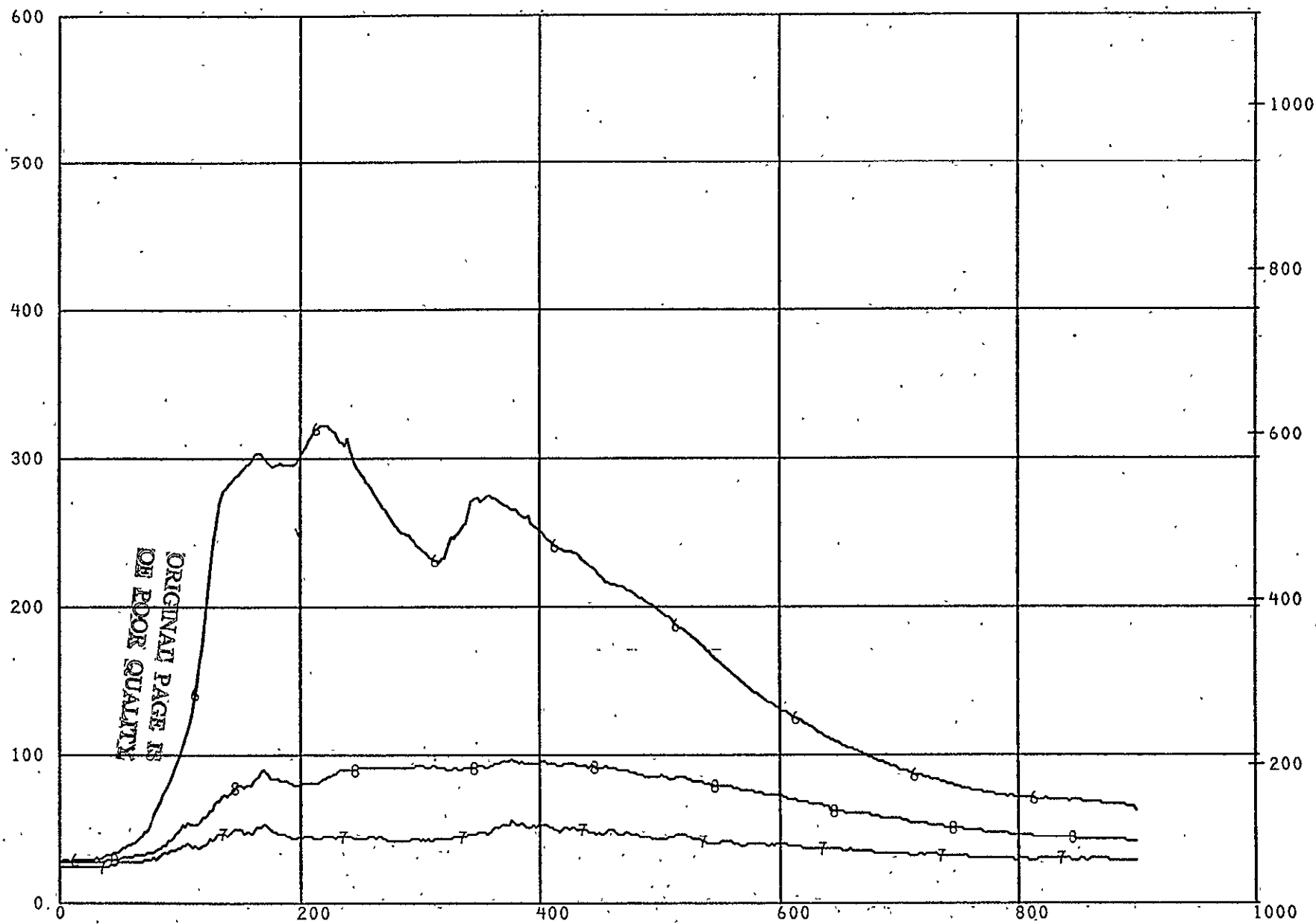


MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5



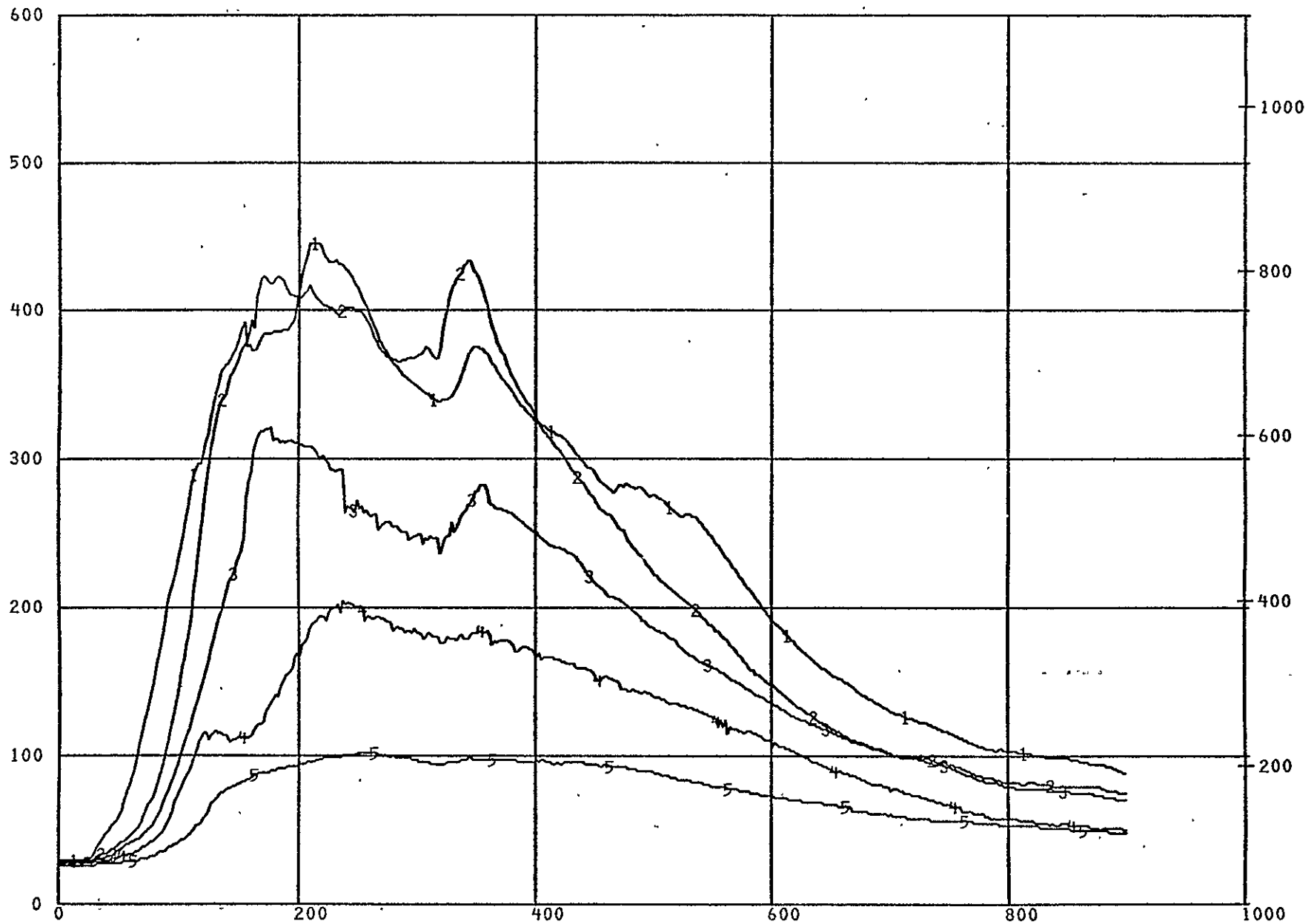
MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

264



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

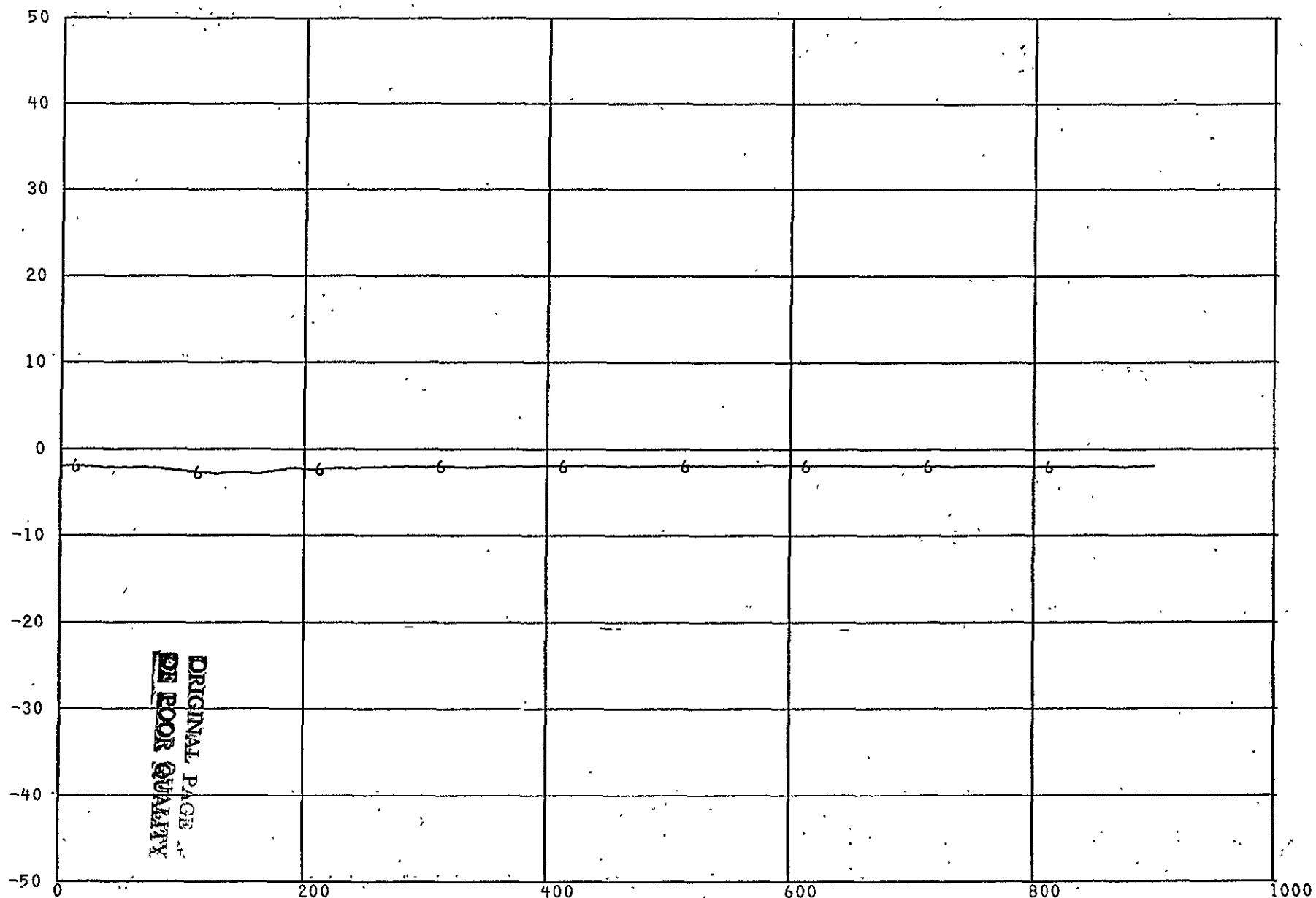
TEST ID 840288 083000

ST15

PLOT NO

6 - 1

REFERENCE TIME 10 22 00.000



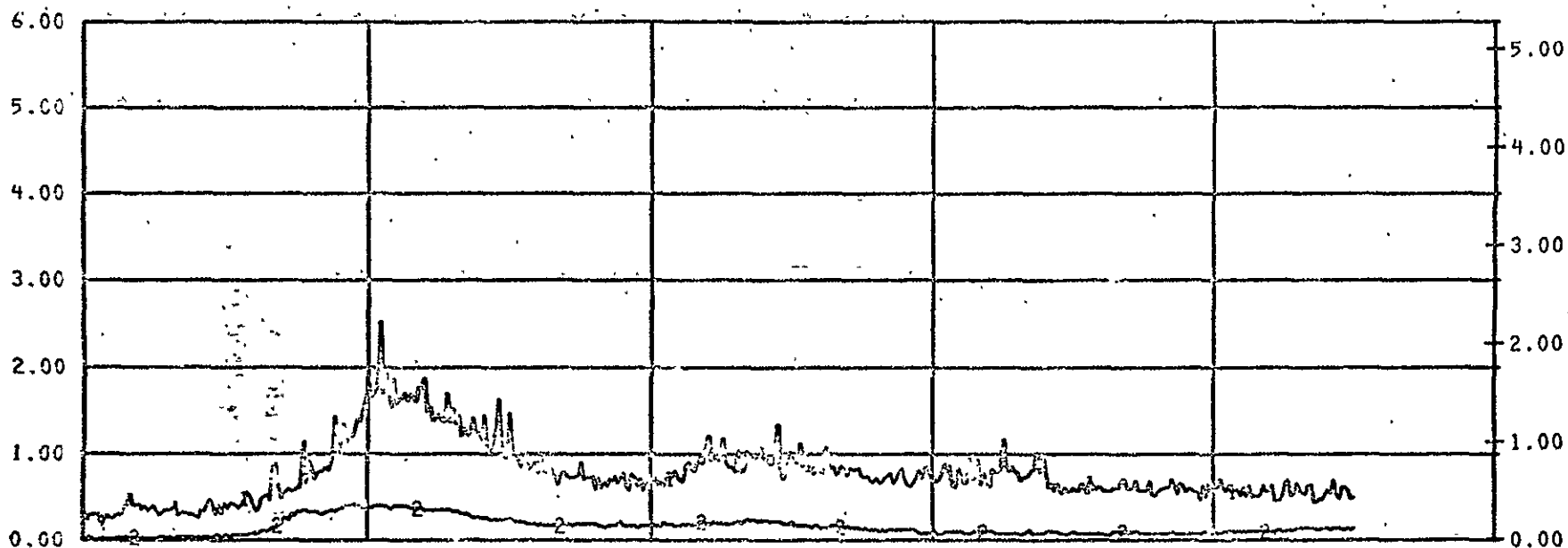
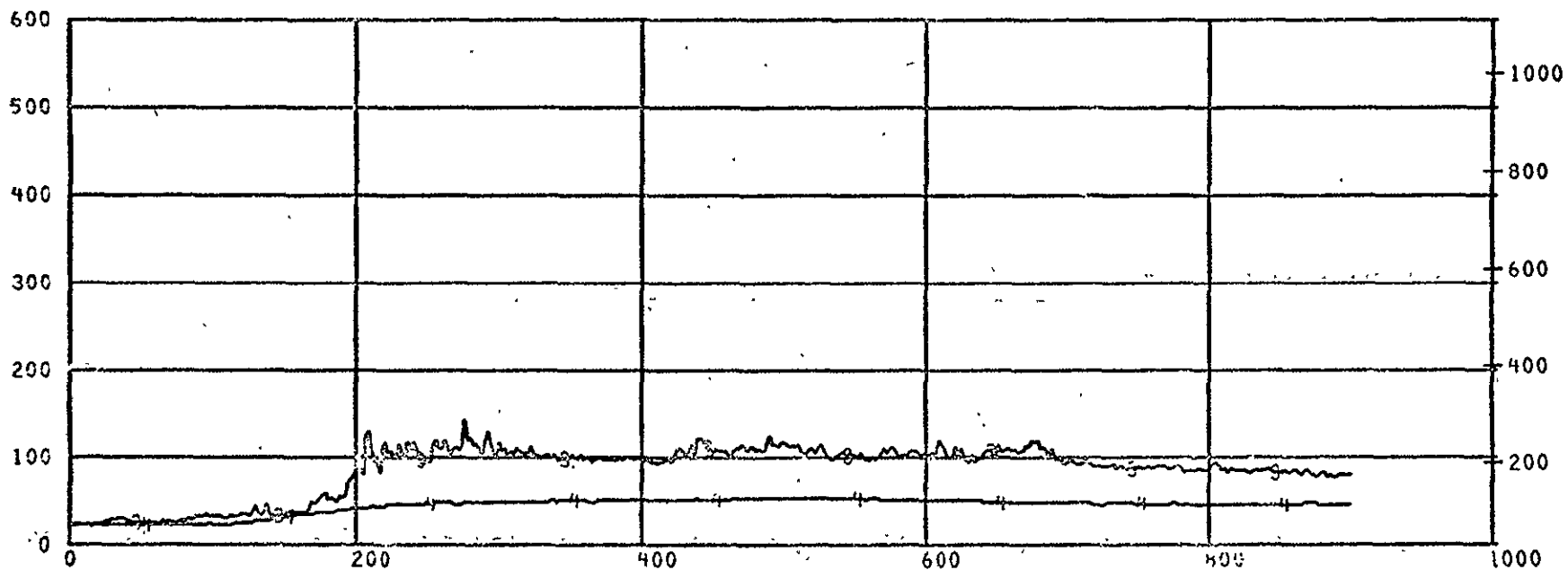
MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

RELATIVE TIME IN SEC
TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
IN-H20 A6

B
T
U
/
F
T
SE
G
F

MEAS. NUMBER	CHANNEL ASGN.
% C1	150
% C2	151
% TC19	139
% TC20	120

RELATIVE TIME IN SEC

TITLE

CALORIMETER OVER FIRE

CALORIMETER

RANGE

0.00 TO 6.00

0.00 TO 6.00

0 TO 600

0 TO 600

UNITS GRID-SYM.

WATT/CM2 A1

WATT/CM2 A2

DEG C B3

DEG C B4

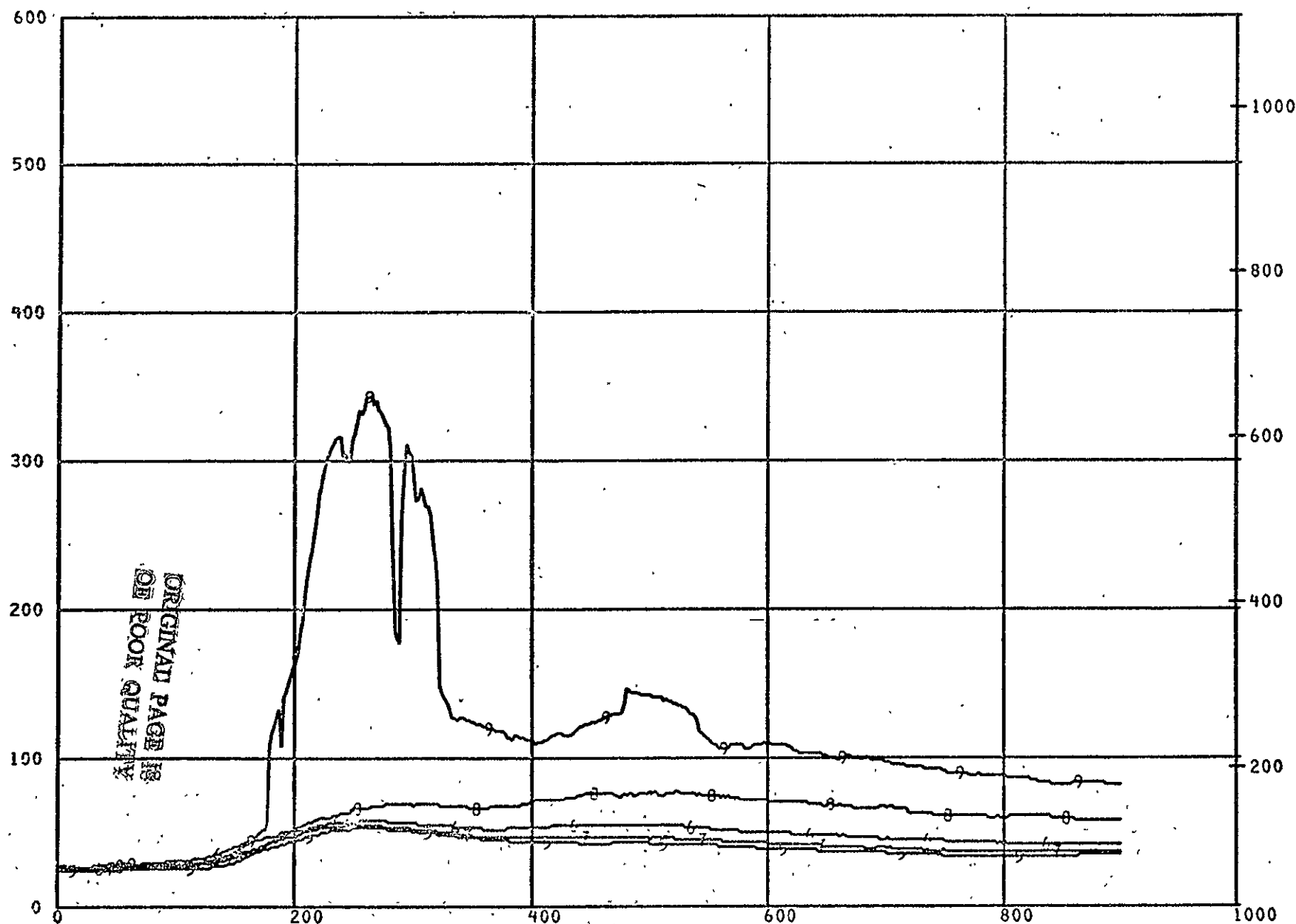
TEST ID 840288 087000

ST23

PLOT NO

2 - 1

REFERENCE TIME 08 18 00.000



MEAS. NUMBER CHANNEL ASGN.

TC05	105
TC06	106
TC07	107
TC12	132
TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE

0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

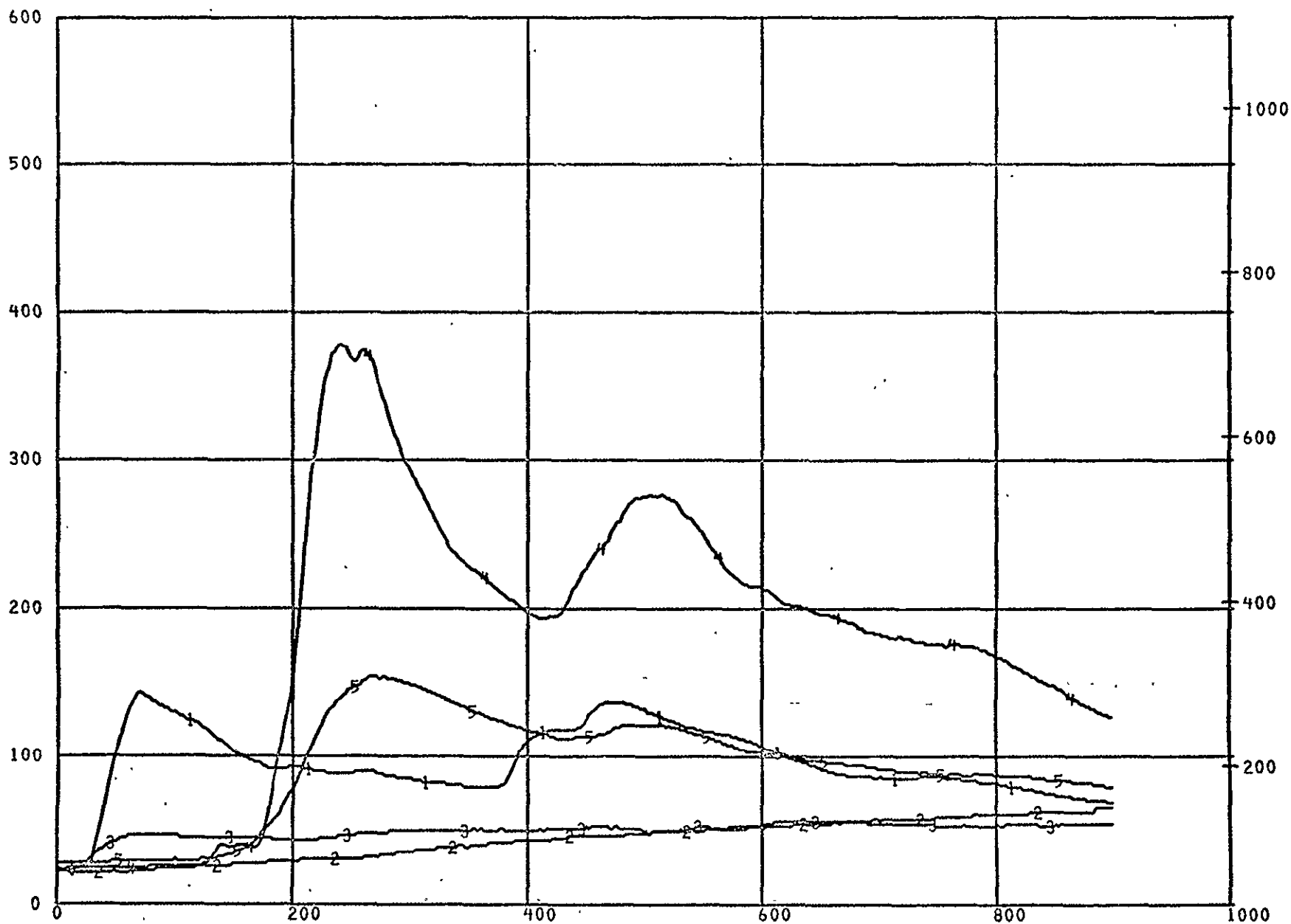
UNITS

DEG C
DEG C
DEG C
DEG C
DEG C

GRID-SYM

A5
A6
A7
A8
A9

268



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

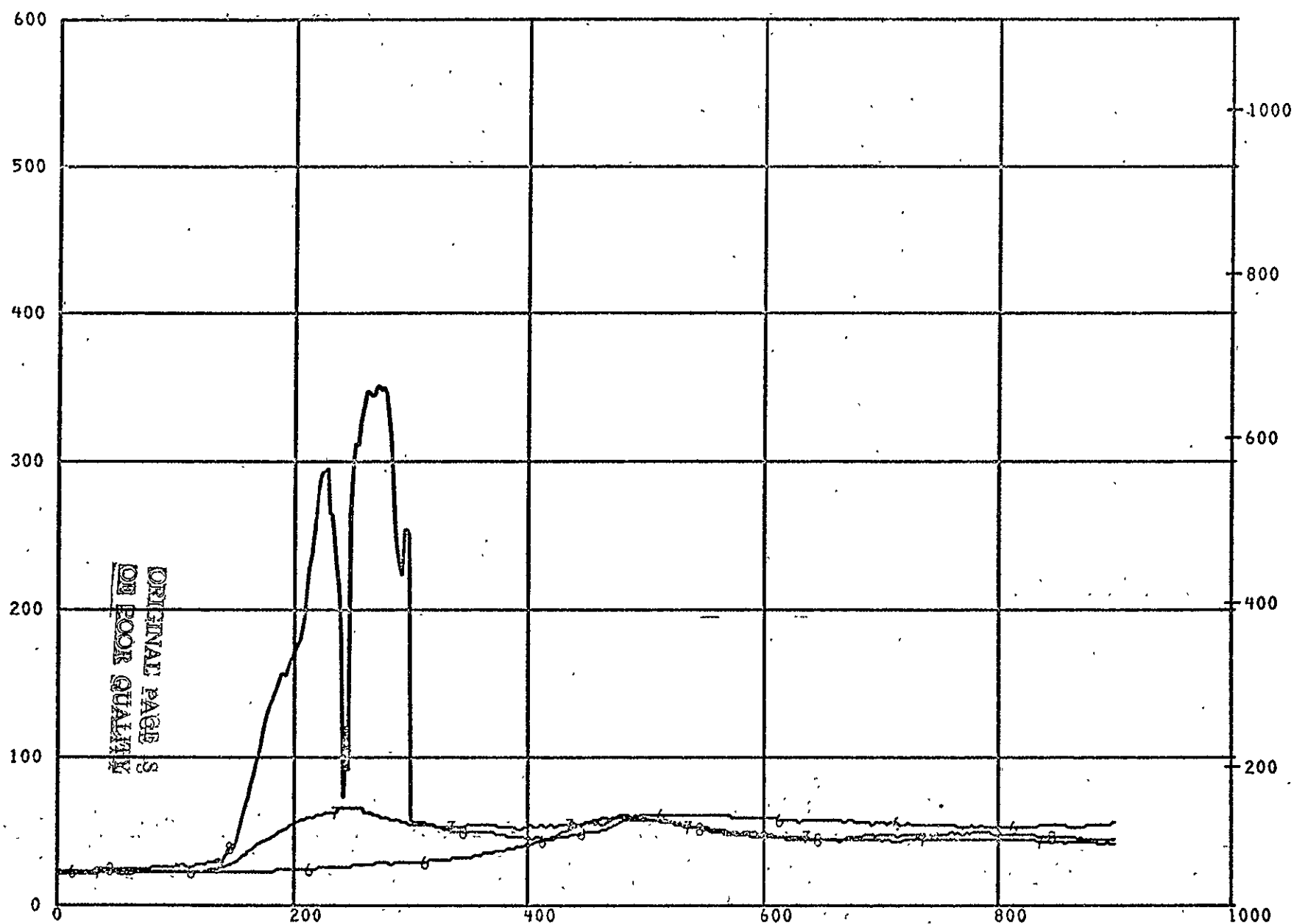
UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 087000

ST23

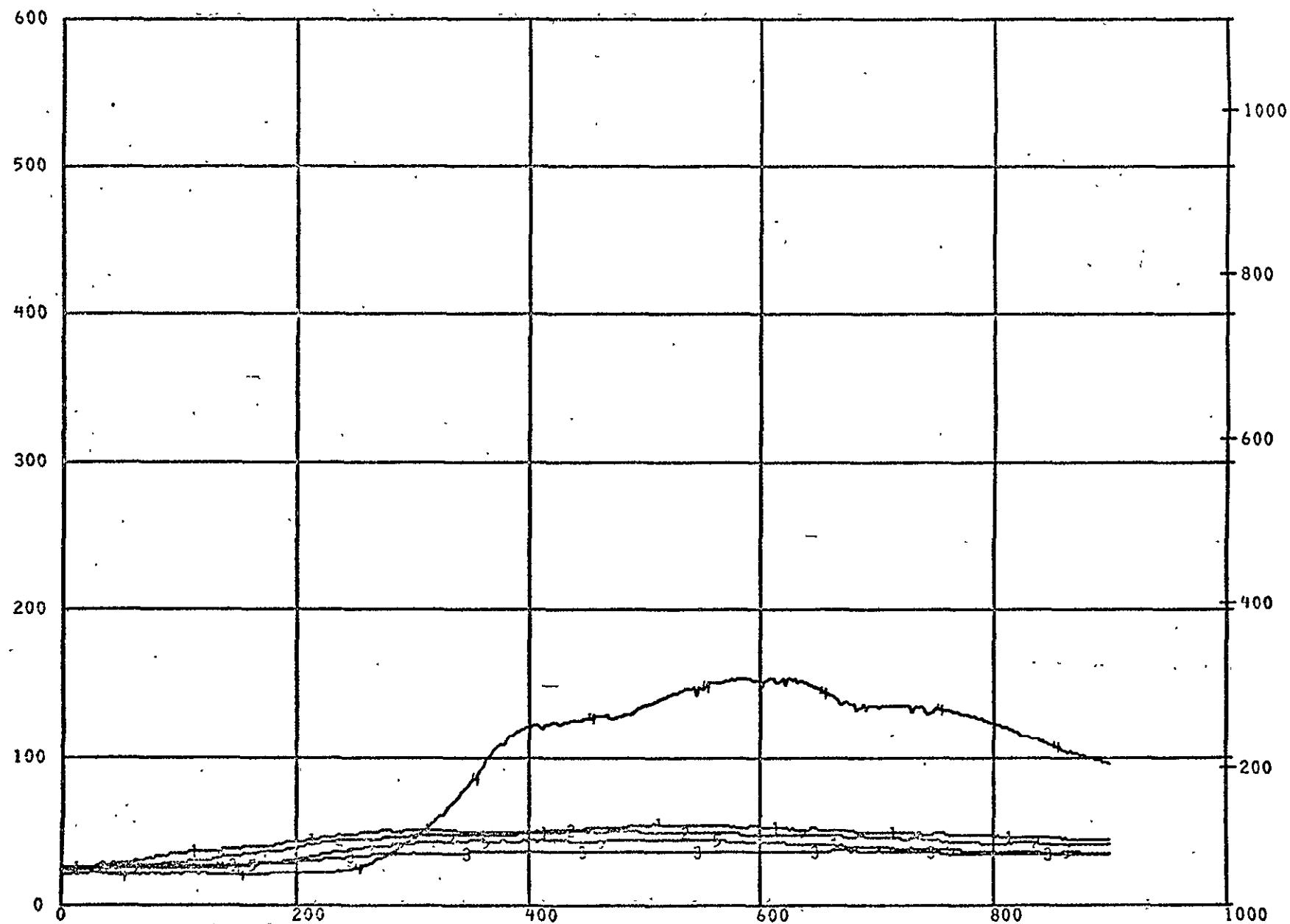
PLOT NO 4 - 1

REFERENCE TIME 08 18 00.000



MEAS. NUMBER	CHANNEL ASGN.
TC04	104
TC10	130
TC11	131

RELATIVE TIME IN SEC
TITLERANGE
0 TO 600
0 TO 600
0 TO 600UNITS GRID-SYM
DEG C A6
DEG C A7
DEG C A8



MEAS. NUMBER	CHANNEL ASGN.
§ TC14	134
§ TC15	135
§ TC16	136
§ TC17	137
§ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

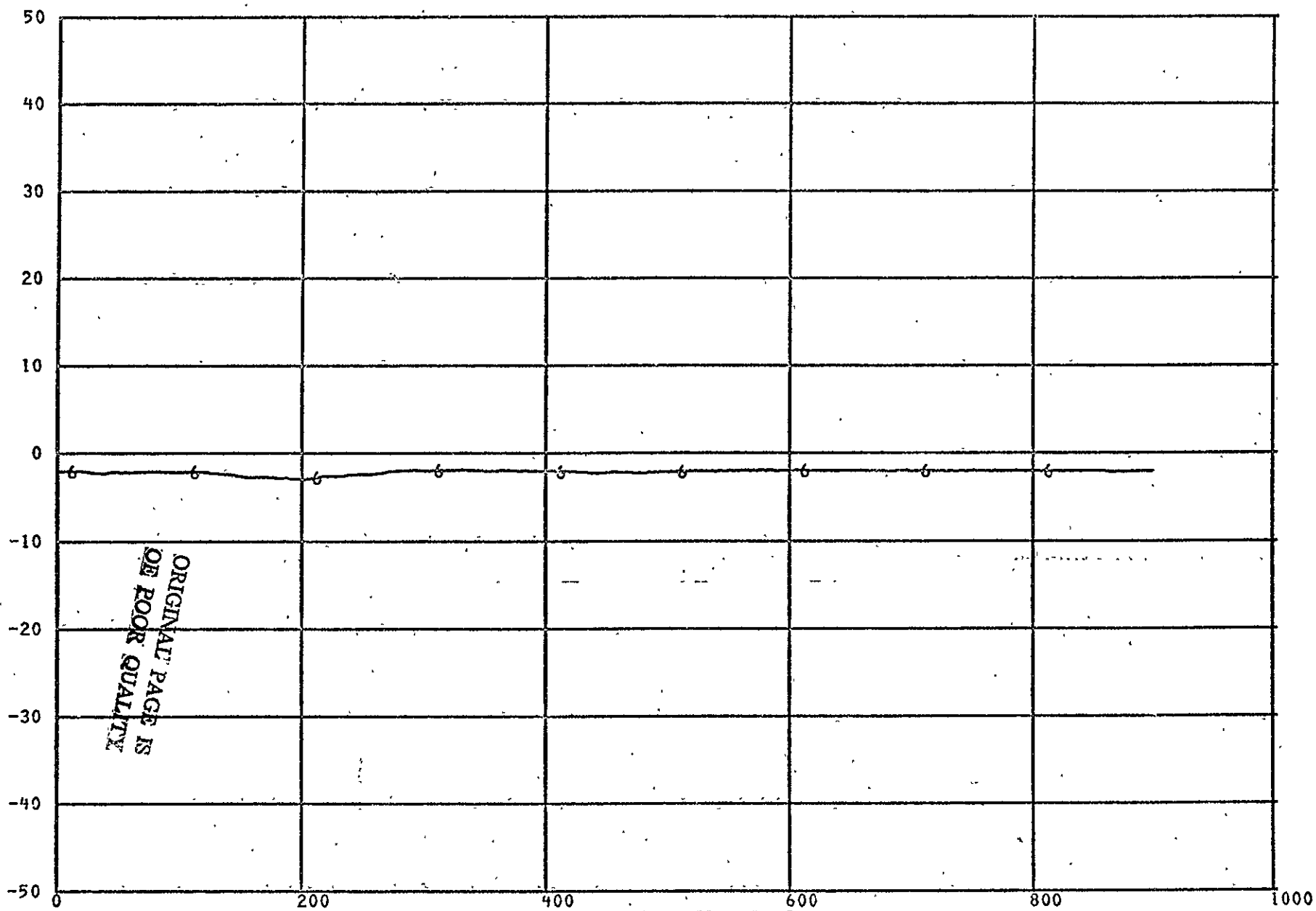
TEST ID 840288 087000

ST23

PLOT NO

6 - 1

REFERENCE TIME 08 18 00.000



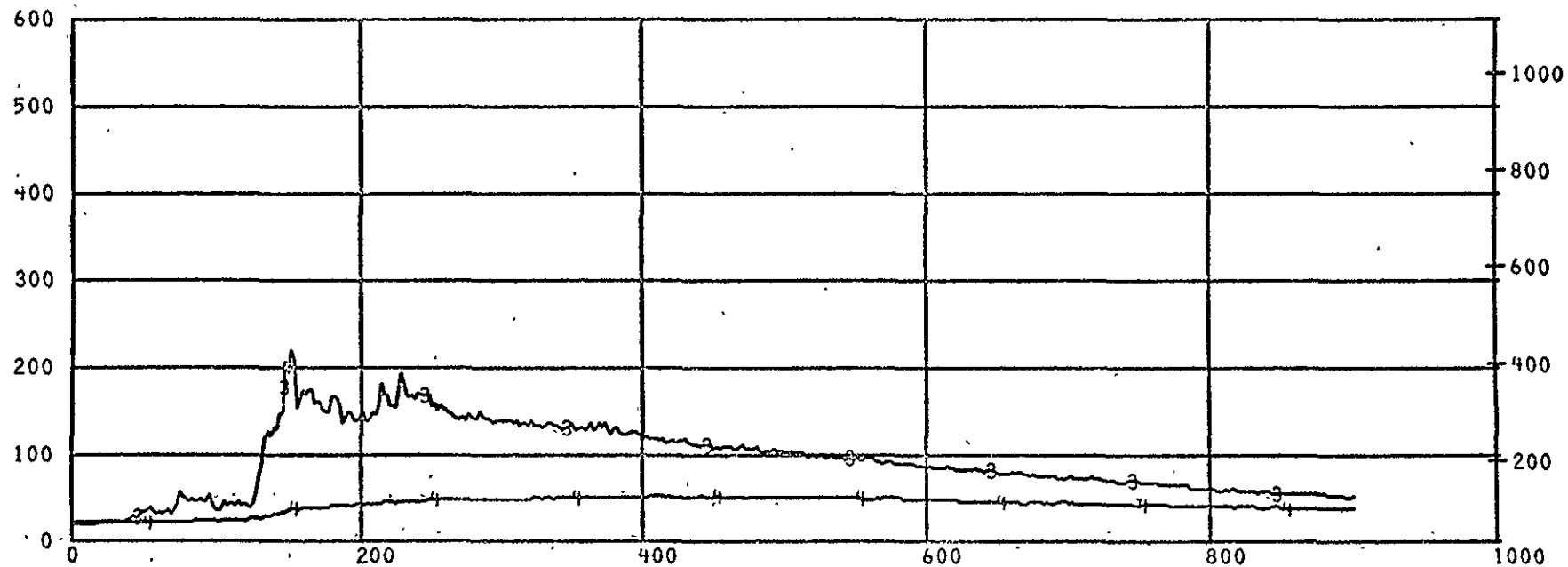
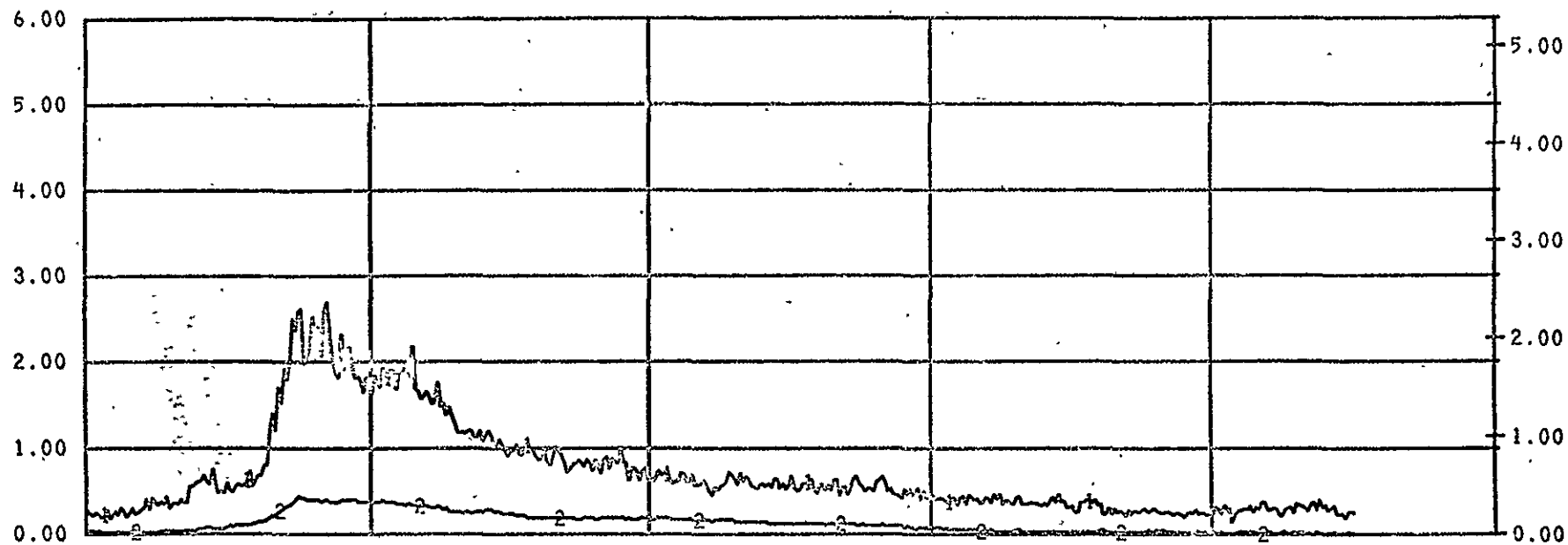
MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
1N-H20 A6

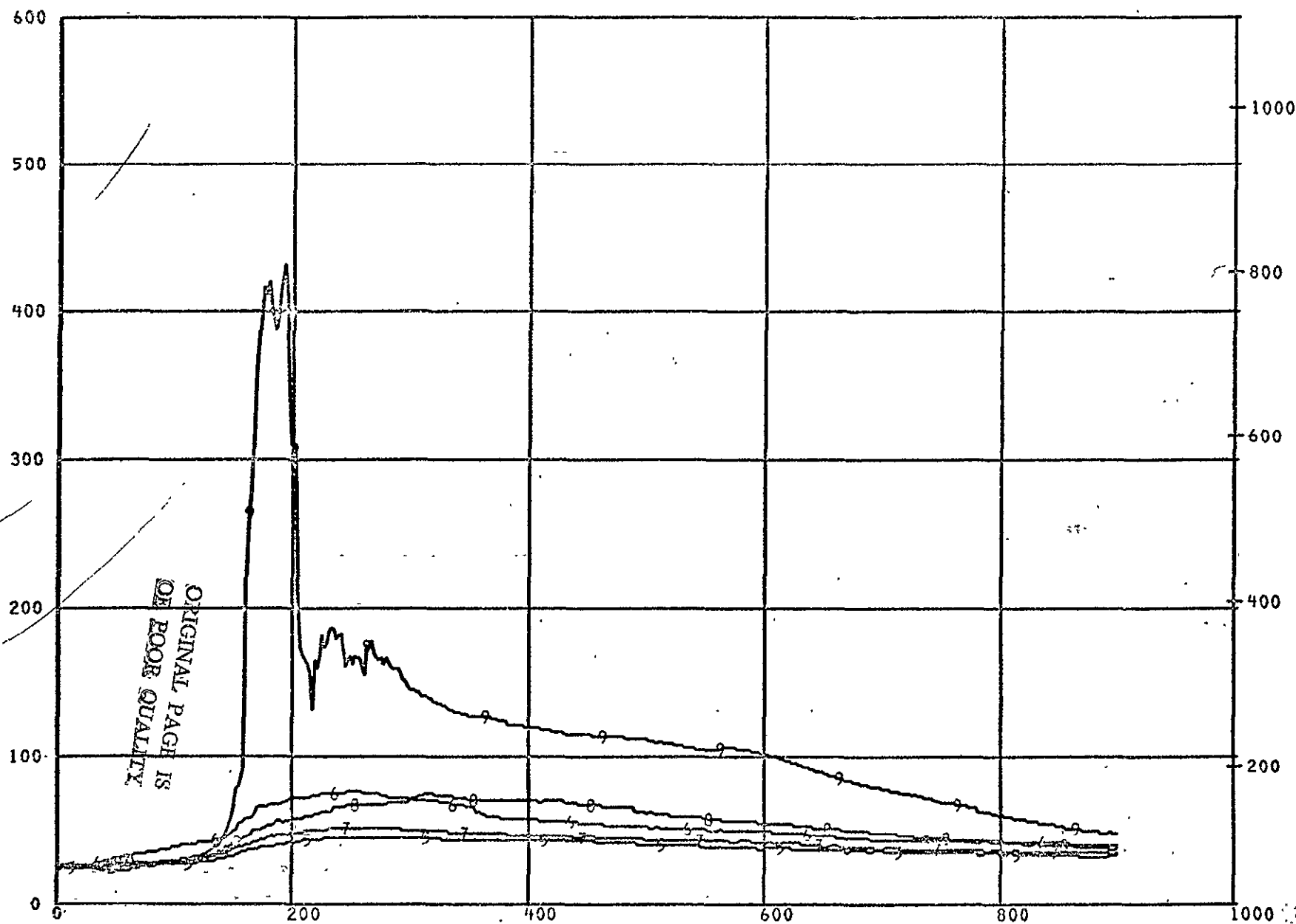


MEAS. NUMBER	CHANNEL ASGN.
\$ C1	150
\$ C2	151
\$ TC19	139
\$ TC20	120

TITLE
CALORIMETER OVER FIRE
CALORIMETER

RANGE
0.00 TO 6.00
0.00 TO 6.00
0 TO 600
0 TO 600

UNITS	GRID-SYM
WATT/CM2	A1
WATT/CM2	A2
DEG C	B3
DEG C	B4



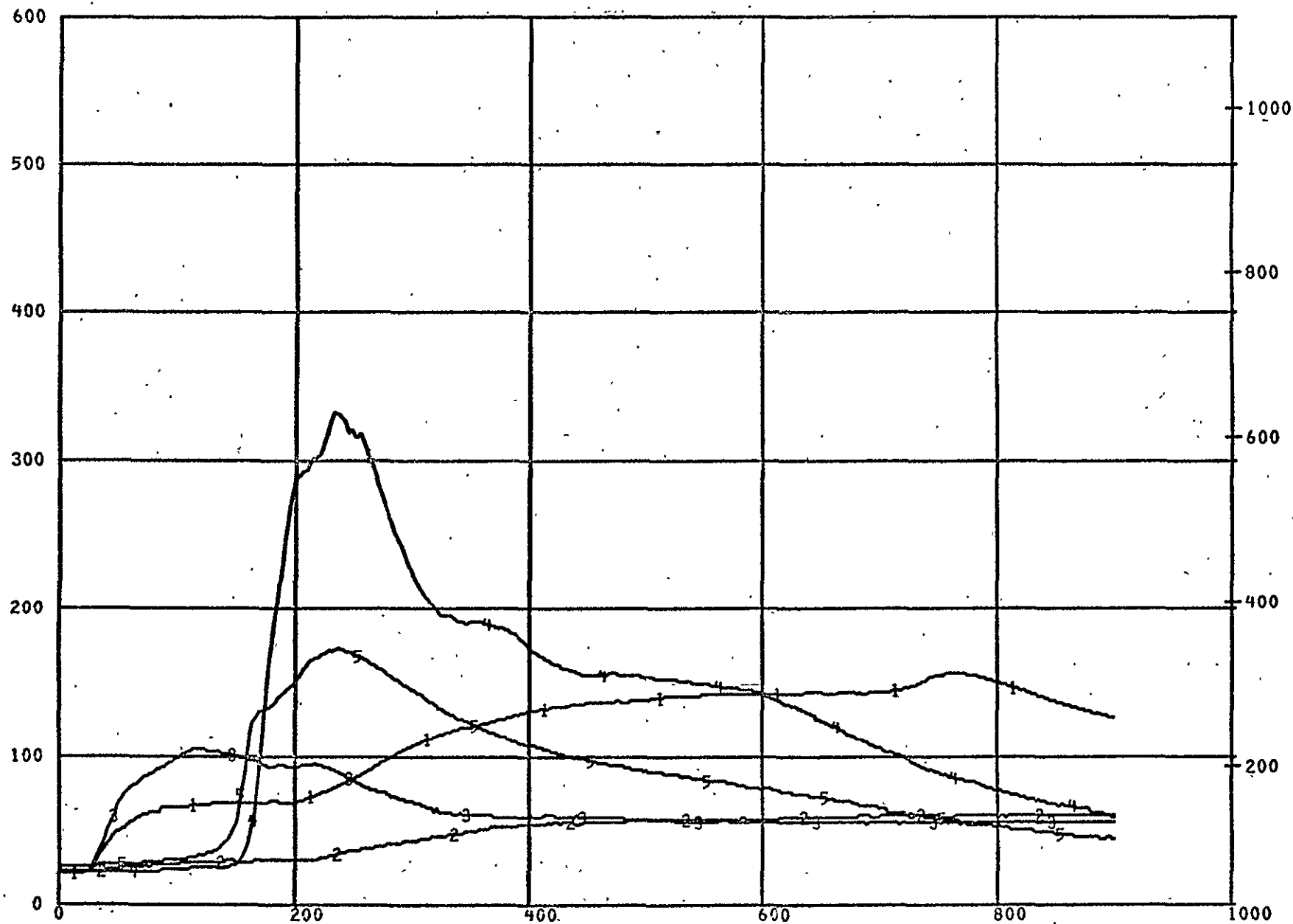
MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

274



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

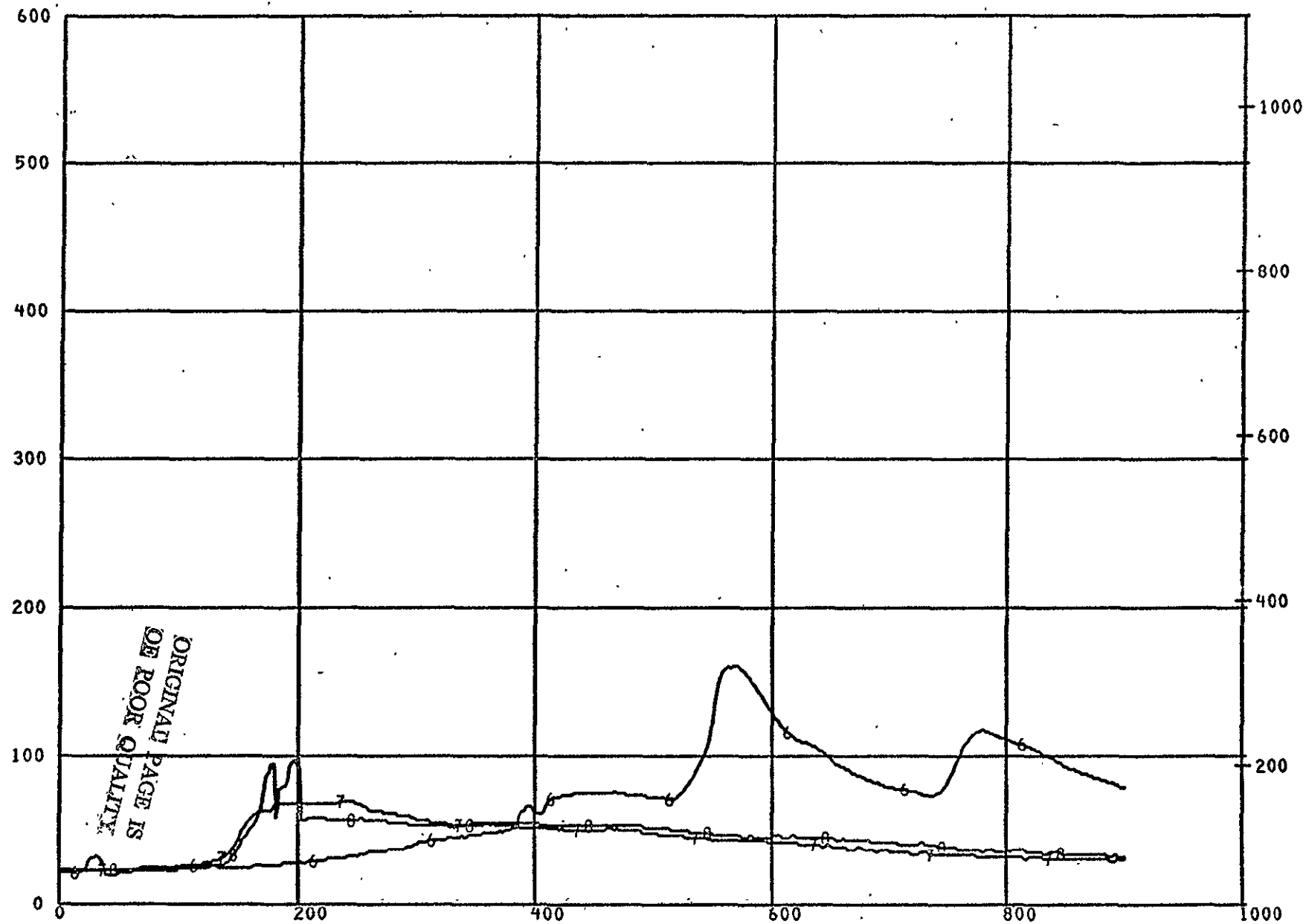
TEST ID 840288 087000

ST24

PLOT NO 4 - 1

REFERENCE TIME 09 50 00.000

275

D
E
G
F

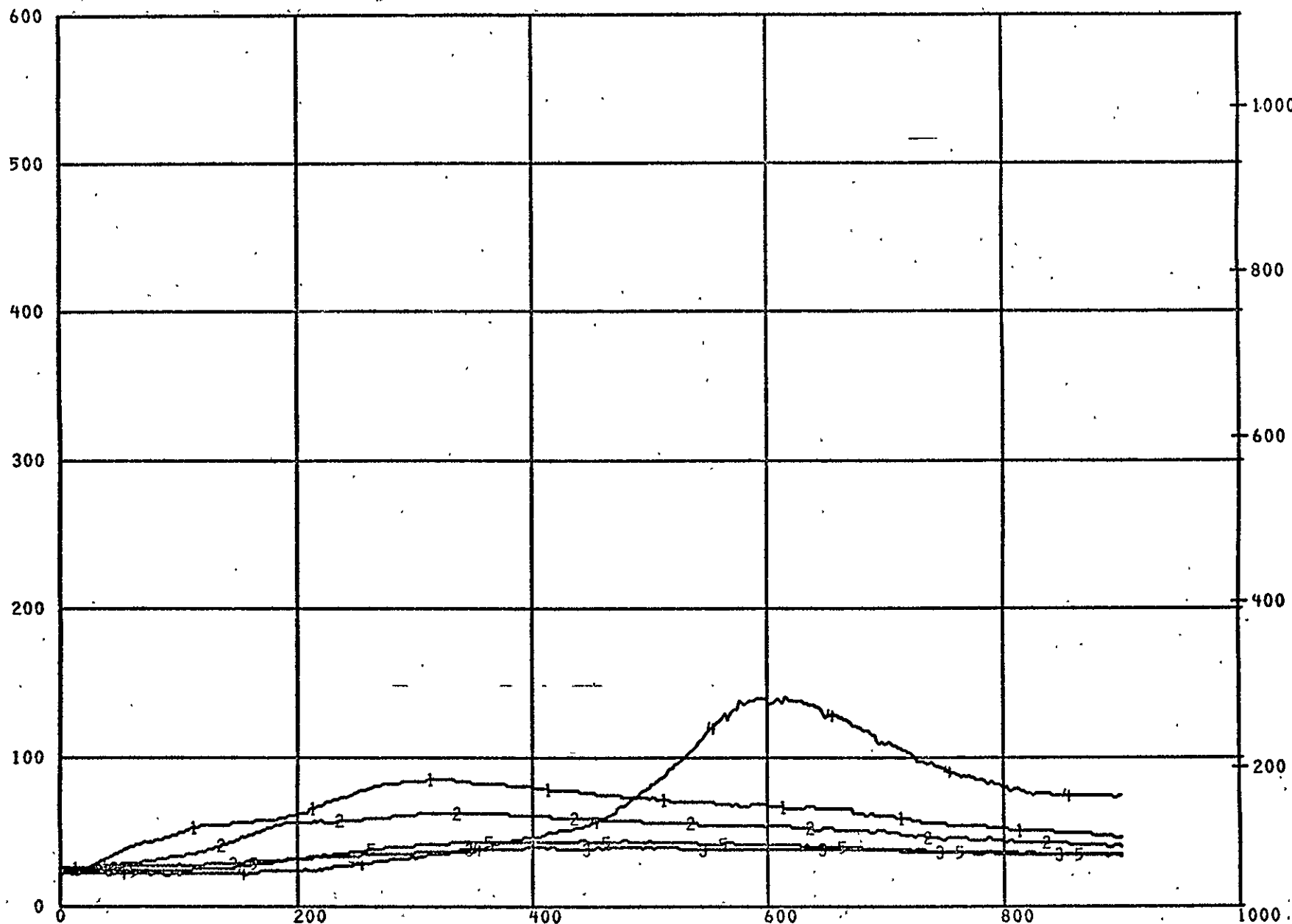
MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

276



MEAS. NUMBER	CHANNEL ASGN.
TC14	134
TC15	135
TC16	136
TC17	137
TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

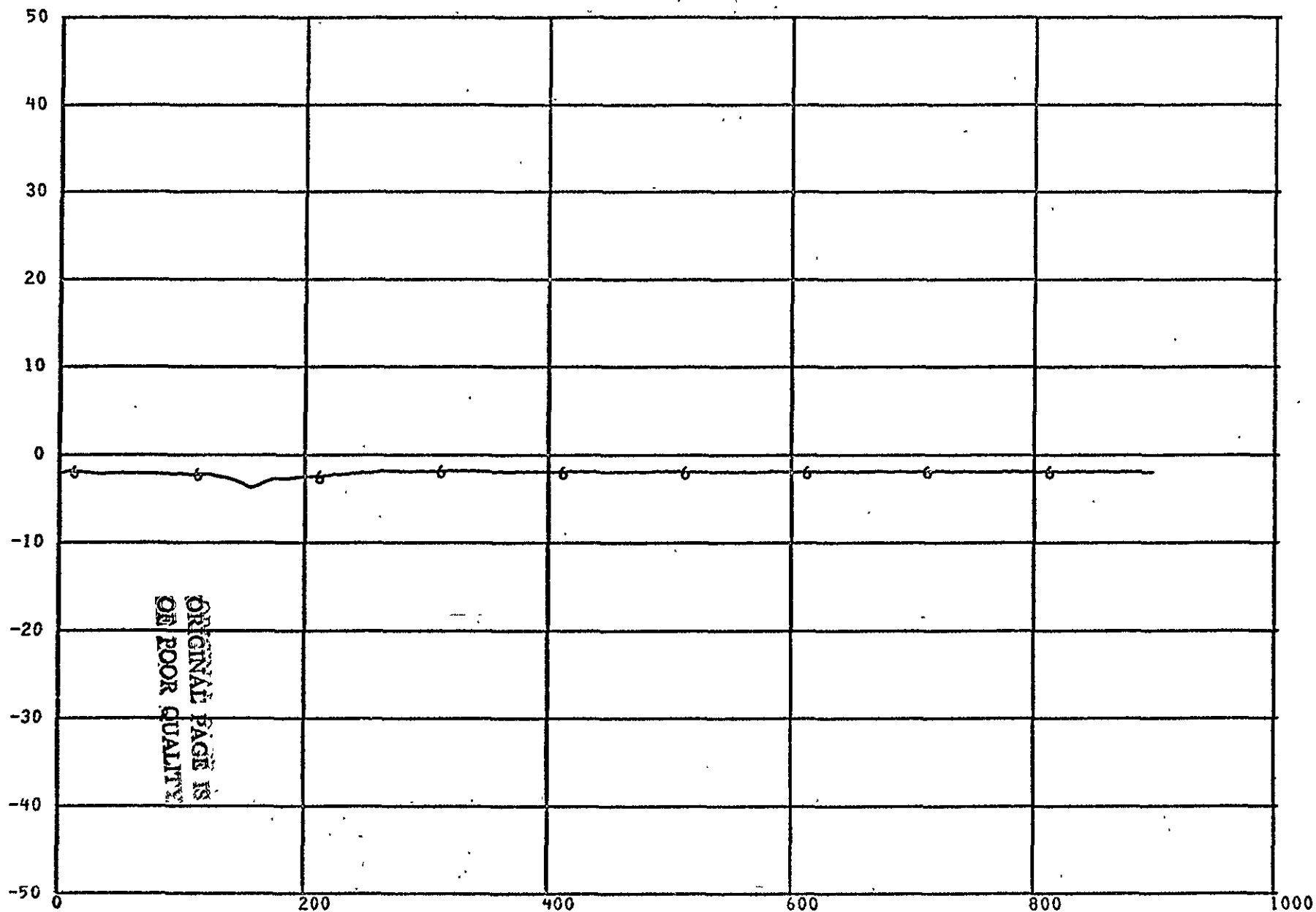
UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 087000

ST24

PLOT NO 6 - 1

REFERENCE TIME 09 50 00.000



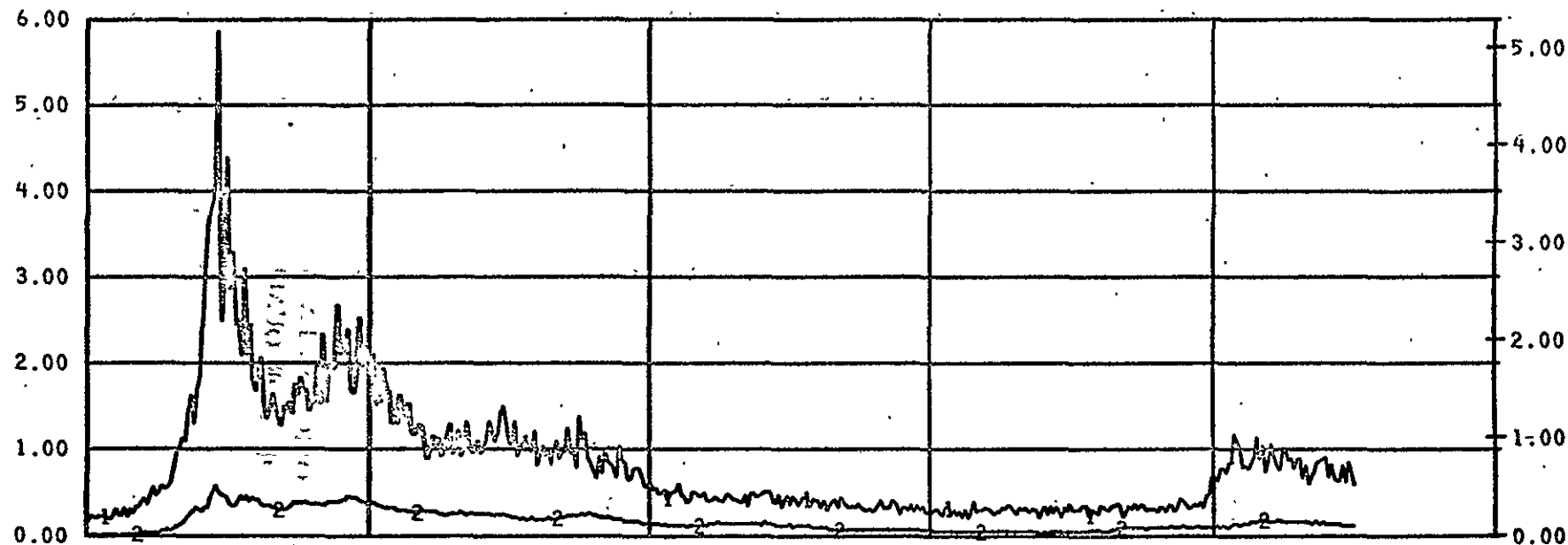
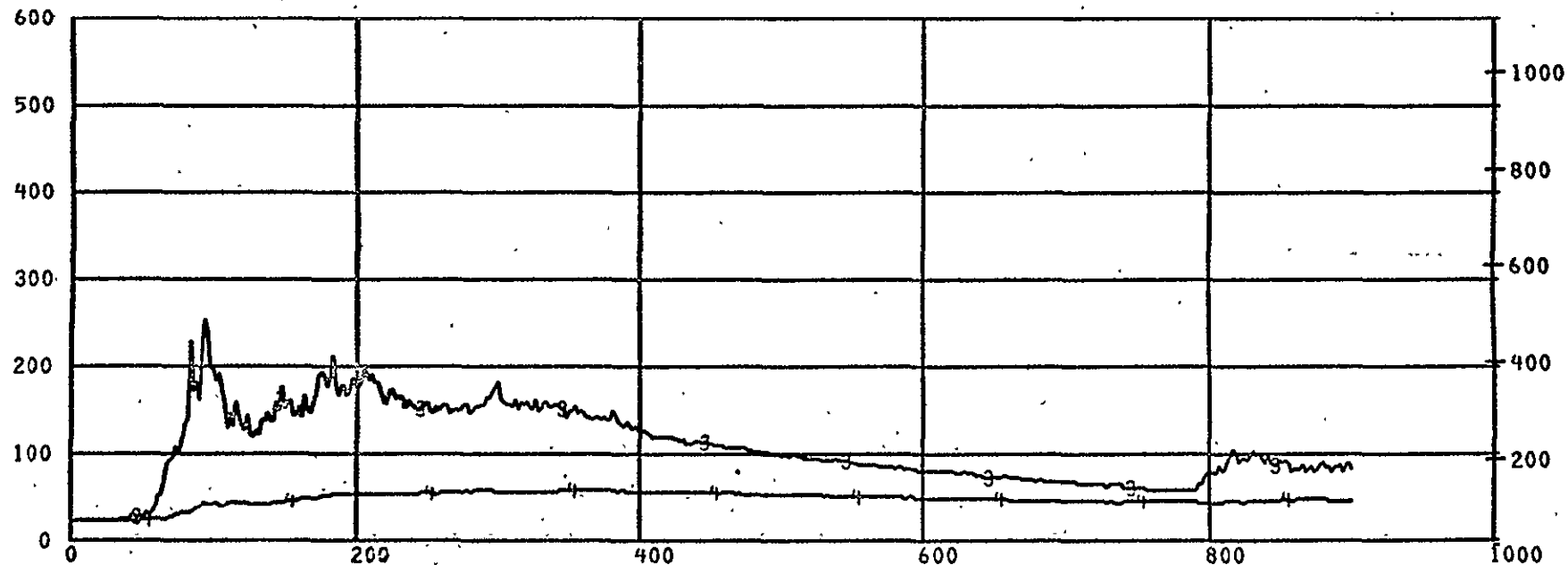
MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
IN-H2O A6

B
T
U
/
F
2
SD
E
G
F

RELATIVE TIME IN SEC

MEAS. NUMBER	CHANNEL ASGN.
\$ C1	150
\$ C2	151
\$ TC19	139
\$ TC20	120

TITLE
CALORIMETER OVER FIRE
CALORIMETER

RANGE
0.00 TO 6.00
0.00 TO 6.00
0 TO 600
0 TO 600

UNITS GRID-SYM
WATT/CM2 A1
WATT/CM2 A2
DEG C B3
DEG C B4

TEST ID 840288 087000

ST25

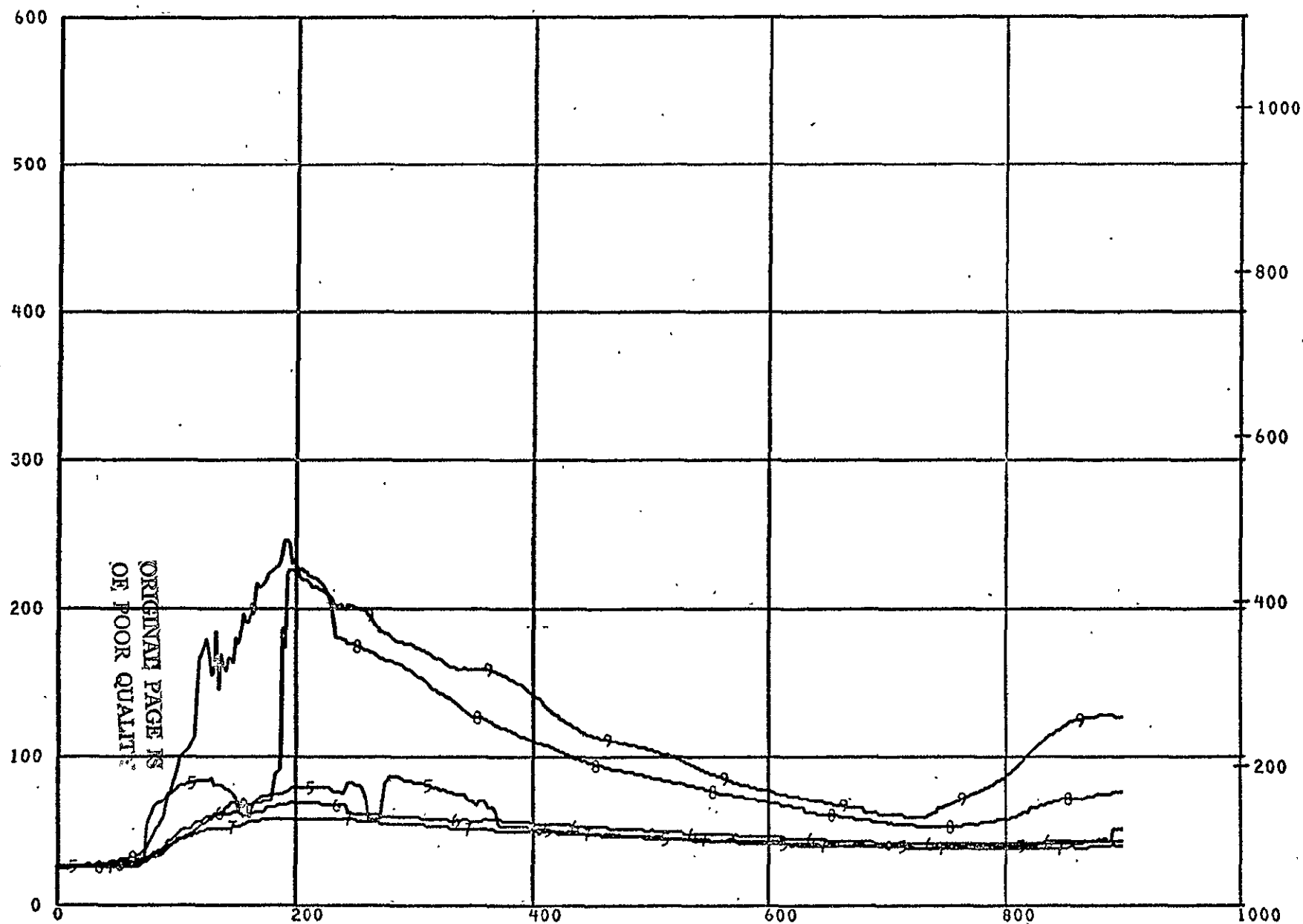
PLOT NO

2 - 1

REFERENCE TIME 10 58 01.000

D
E
G
F

279



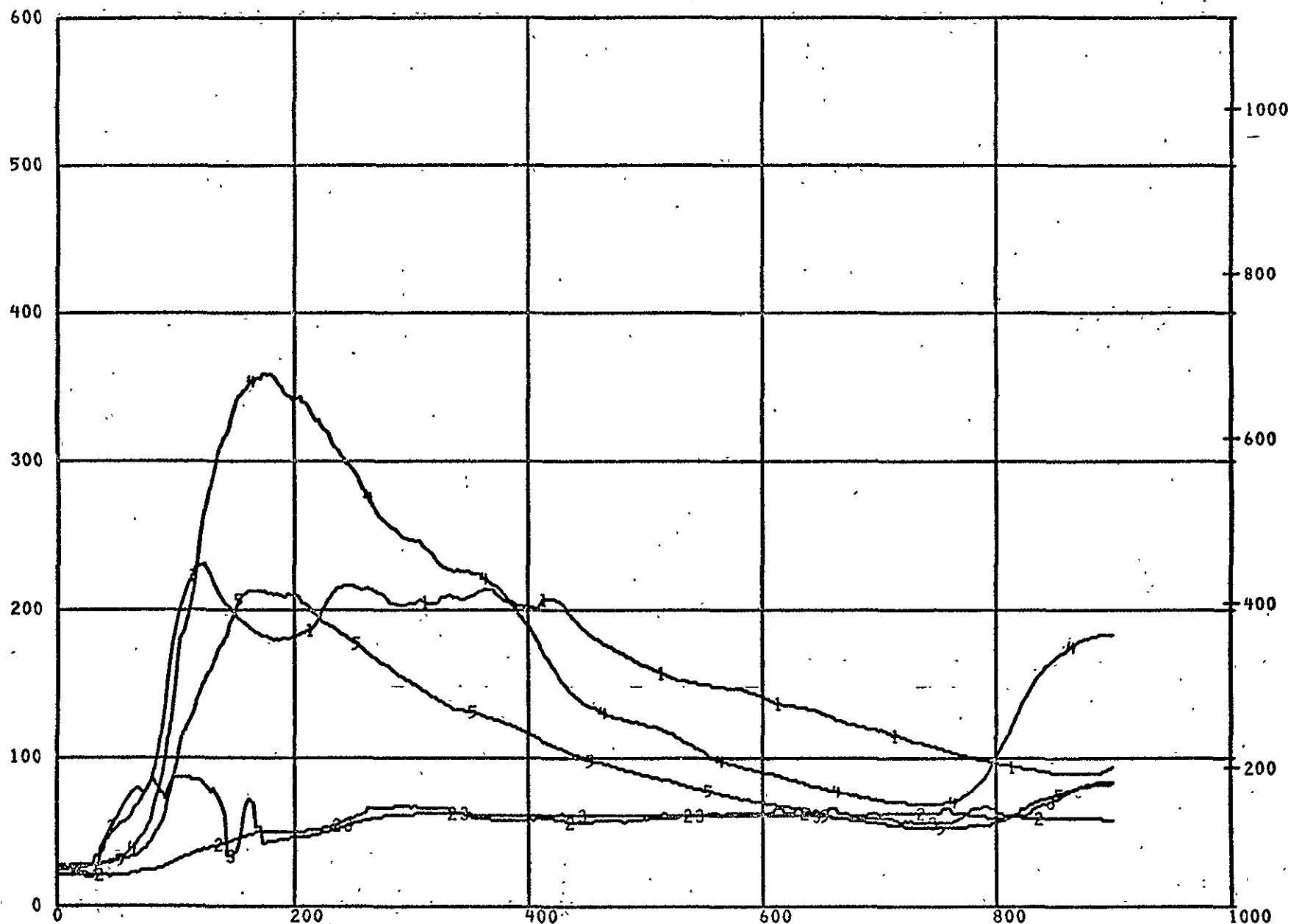
MEAS. NUMBER	CHANNEL ASGN.
TC05	105
TC06	106
TC07	107
TC12	132
TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

280



MEAS. NUMBER	CHANNEL ASGN.
\$ TC01	101
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

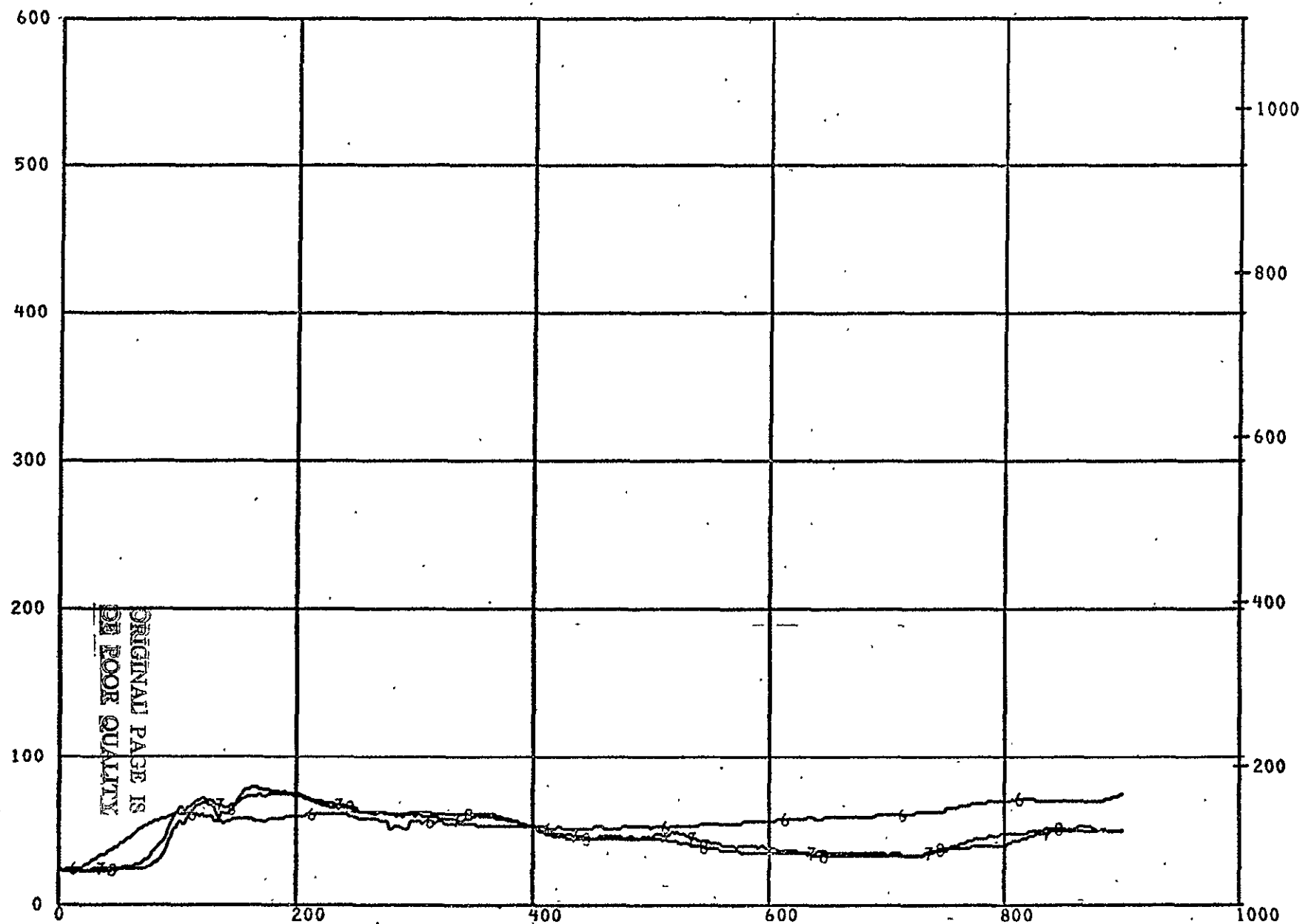
UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 087000

ST25

PLOT NO. 4 - 1

REFERENCE TIME 10 58 01.000

D
E
G
F

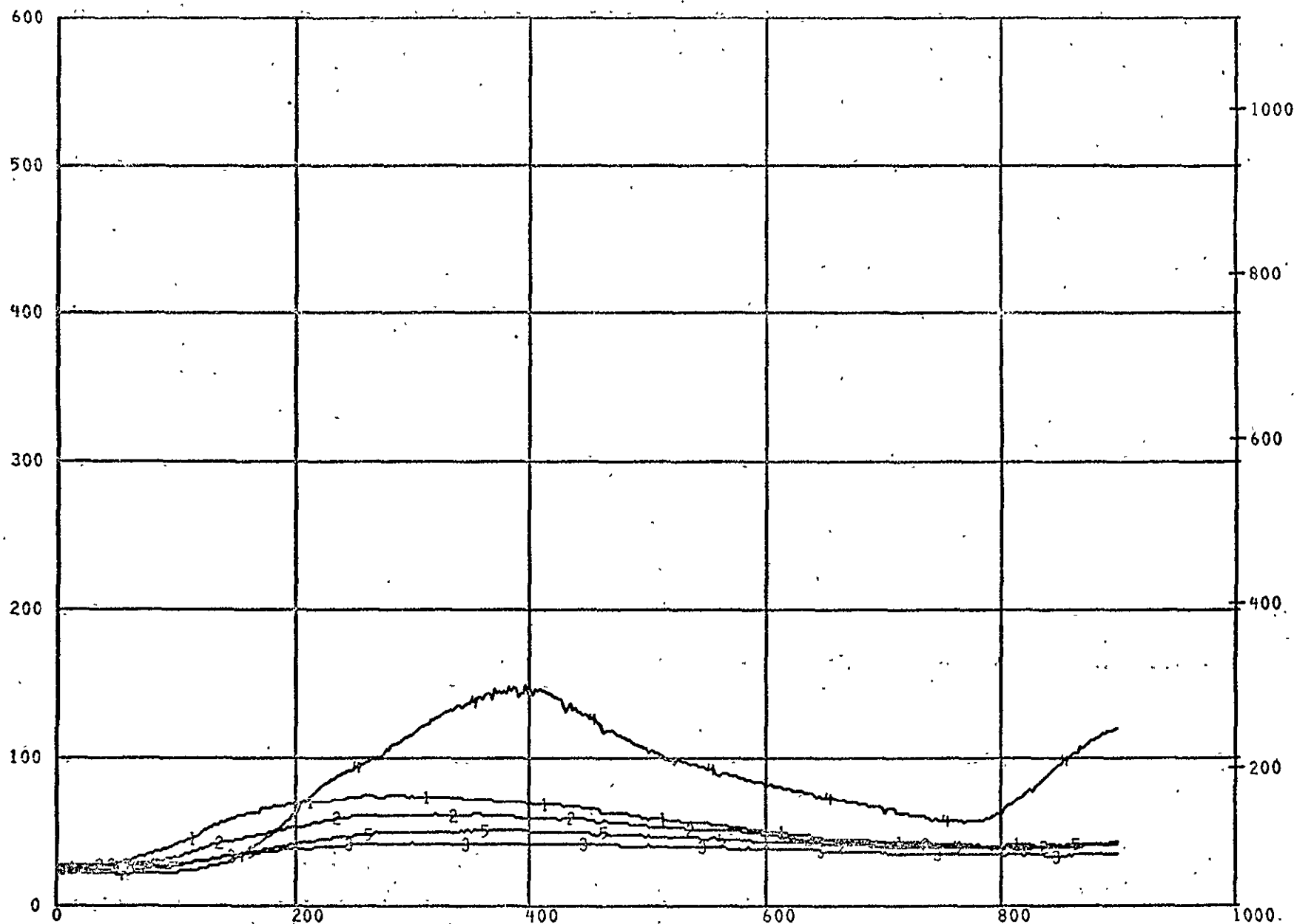
MEAS. NUMBER	CHANNEL ASGN.
TC04	104
TC10	130
TC11	131

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

282

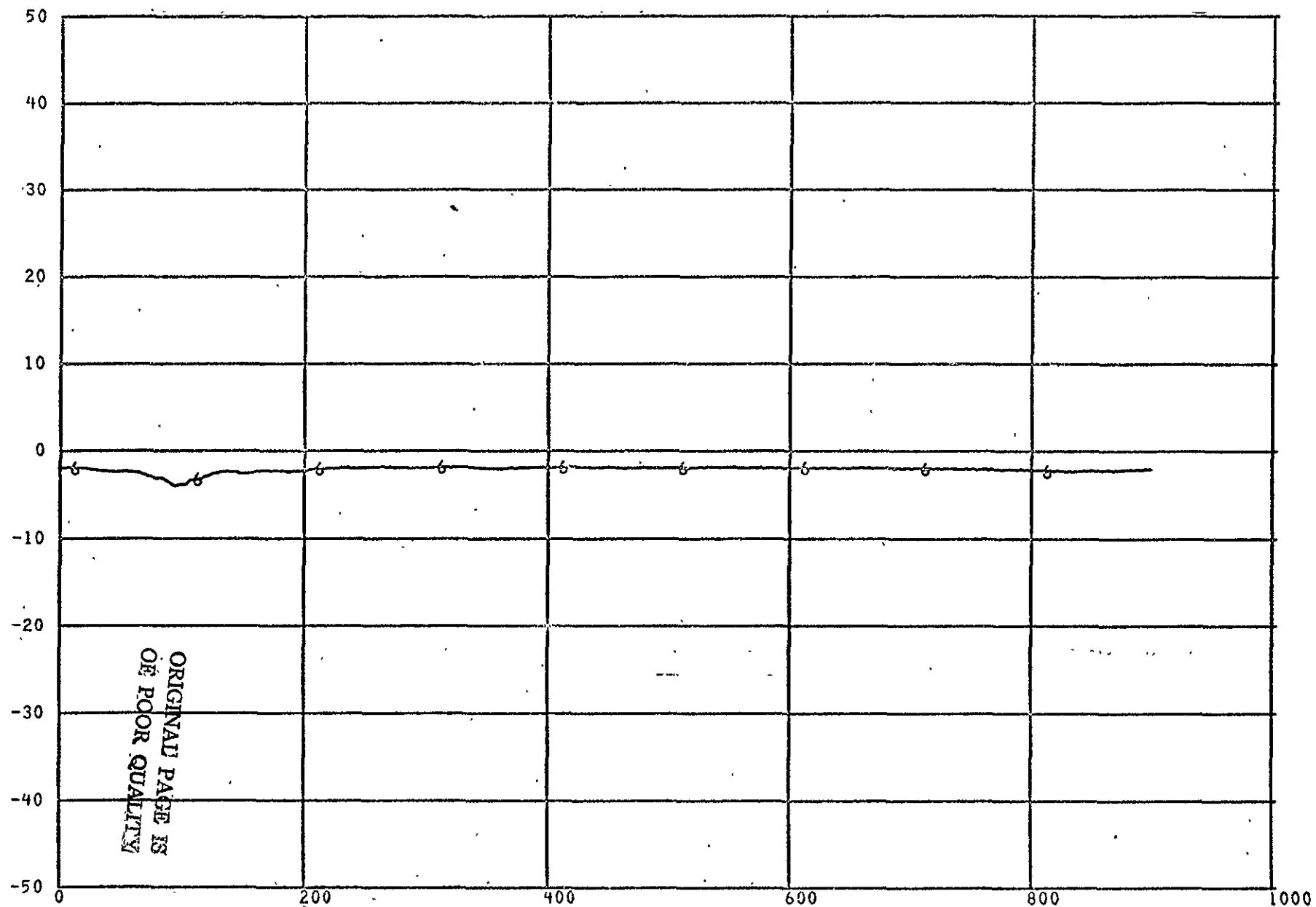


MEAS. NUMBER	CHANNEL ASGN.
TC14	134
TC15	135
TC16	136
TC17	137
TC18	138

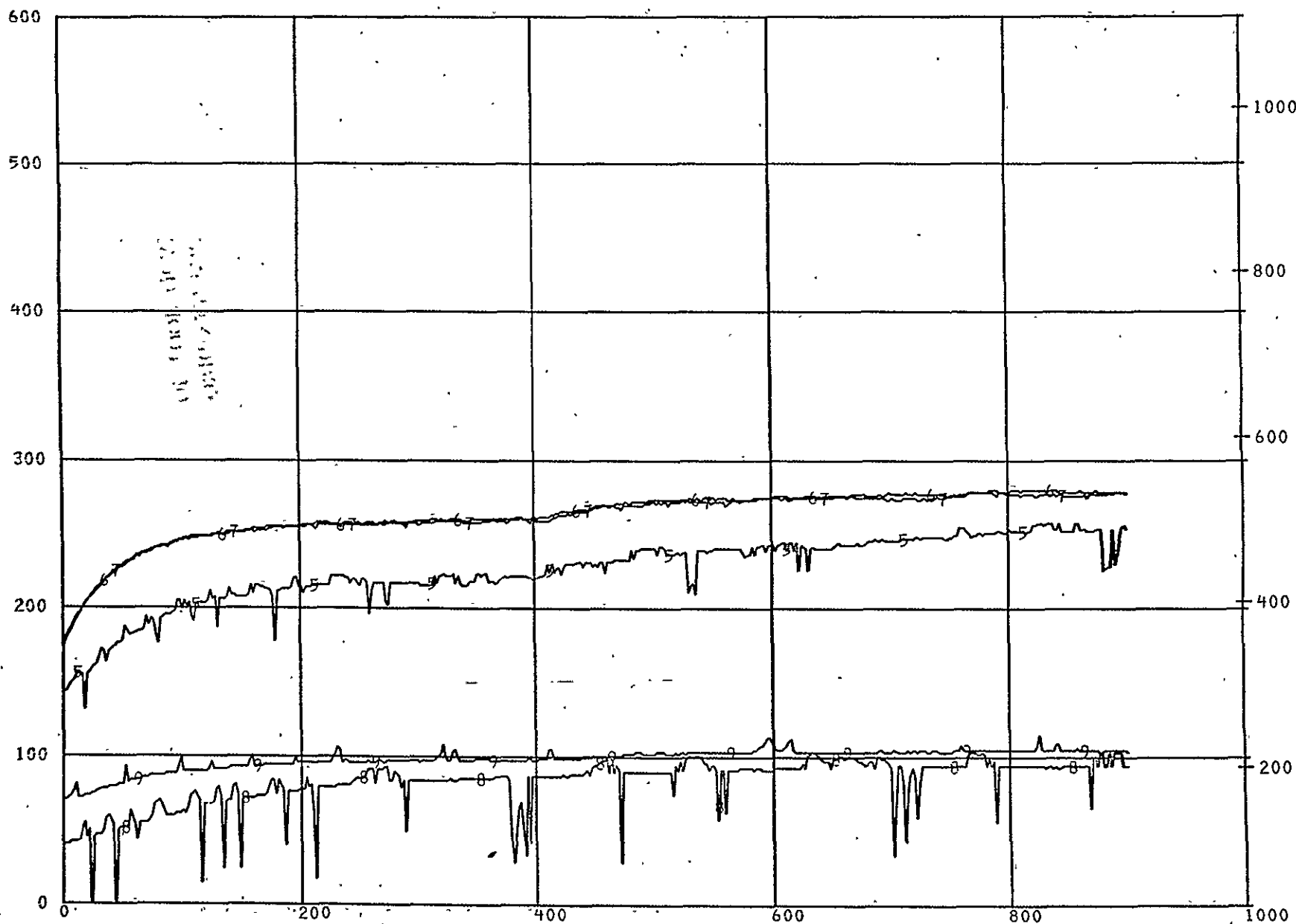
RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

MEAS. NUMBER
PRESSCHANNEL ASGN.
098TITLE
CABIN DELTA PRESSURERANGE
0.0 TO 20.0UNITS GRID-SYM
IN-H20 A6

284



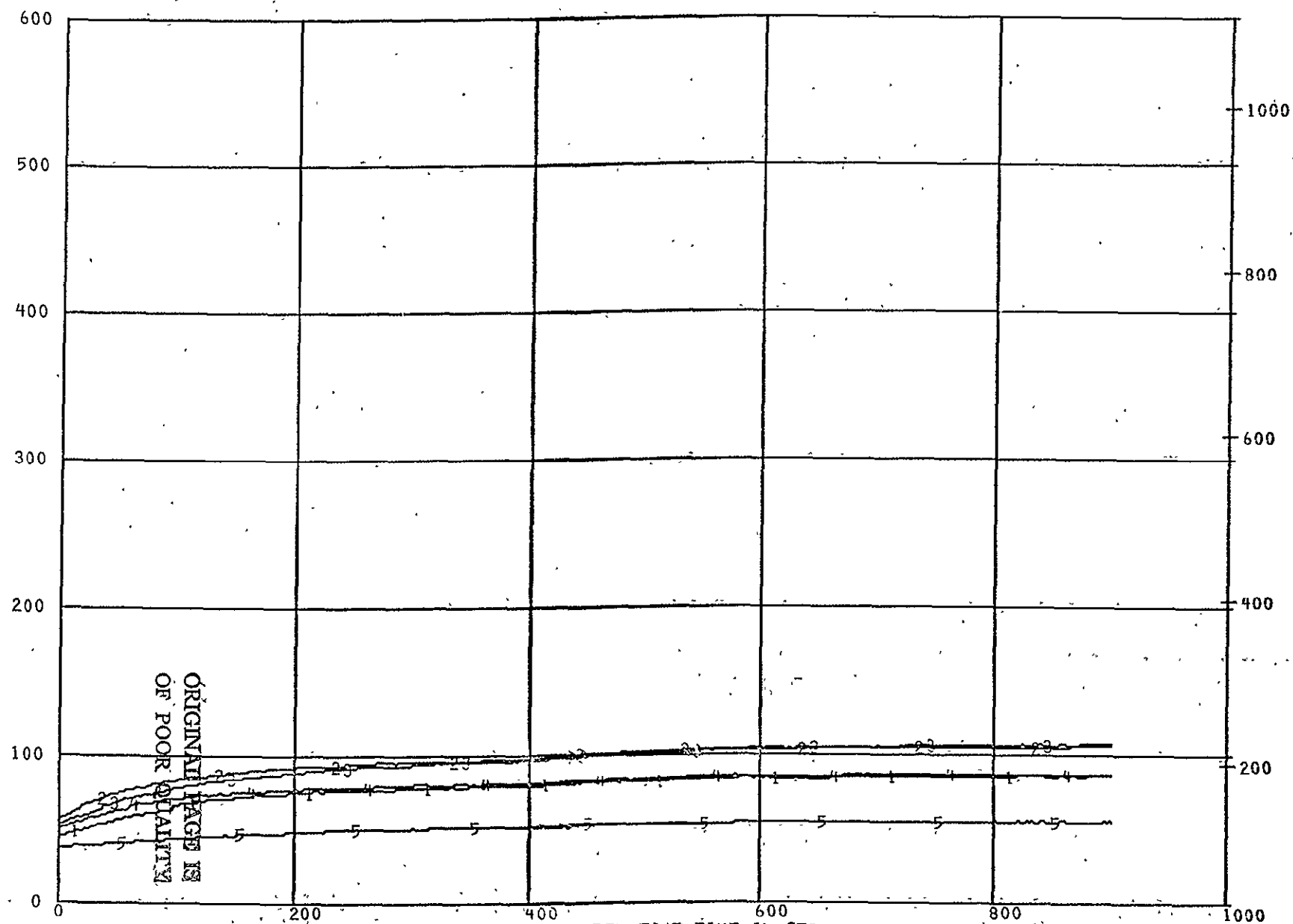
MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

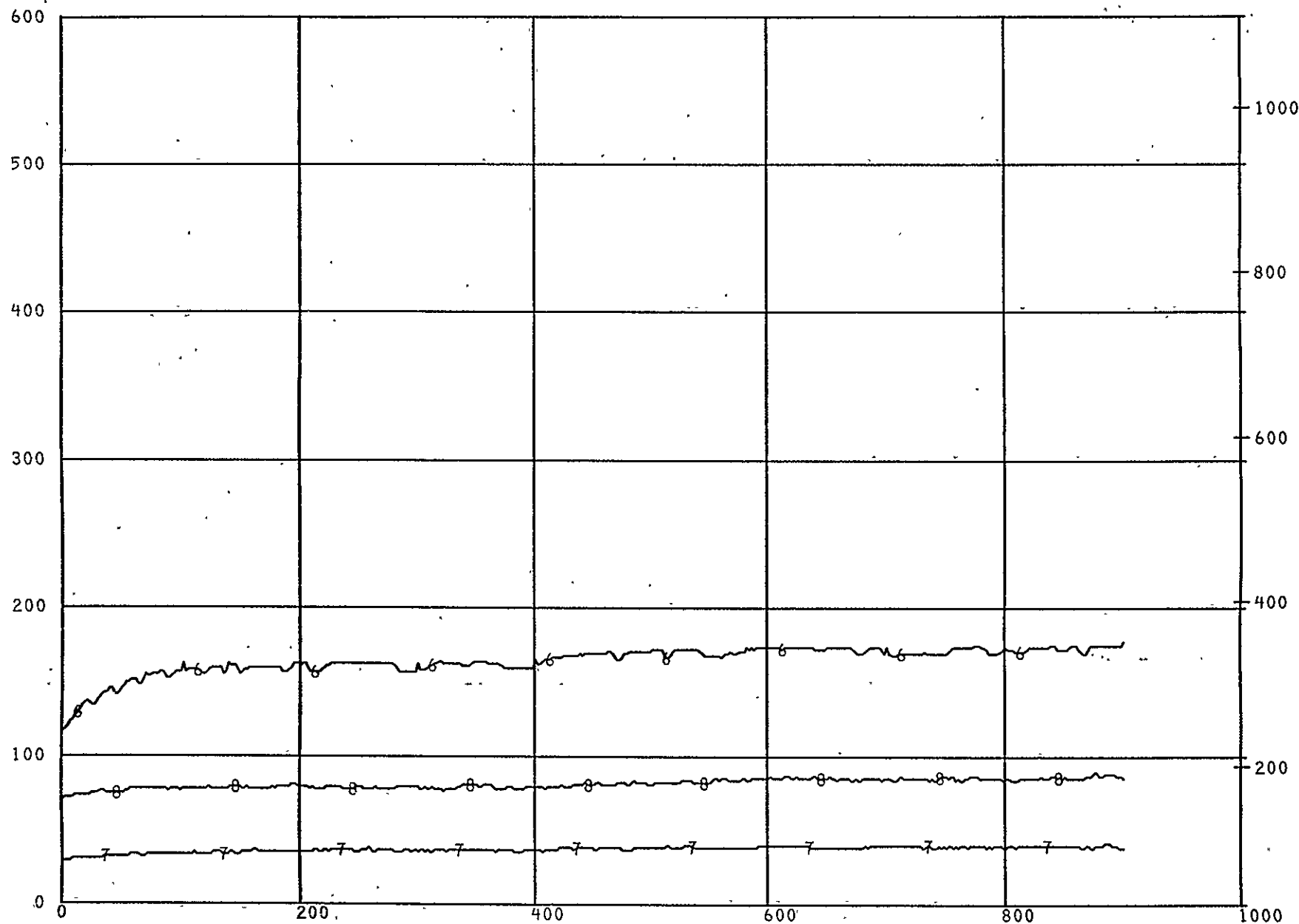
UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

285



MEAS. NUMBER	CHANNEL ASGN.	TITLE	RANGE	UNITS	GRID-SYM
\$ TC01	101		0 TO 600	DEG C	A1
\$ TC02	102		0 TO 600	DEG C	A2
\$ TC03	103		0 TO 600	DEG C	A3
\$ TC09	109		0 TO 600	DEG C	A4
\$ TC08	108		0 TO 600	DEG C	A5

286



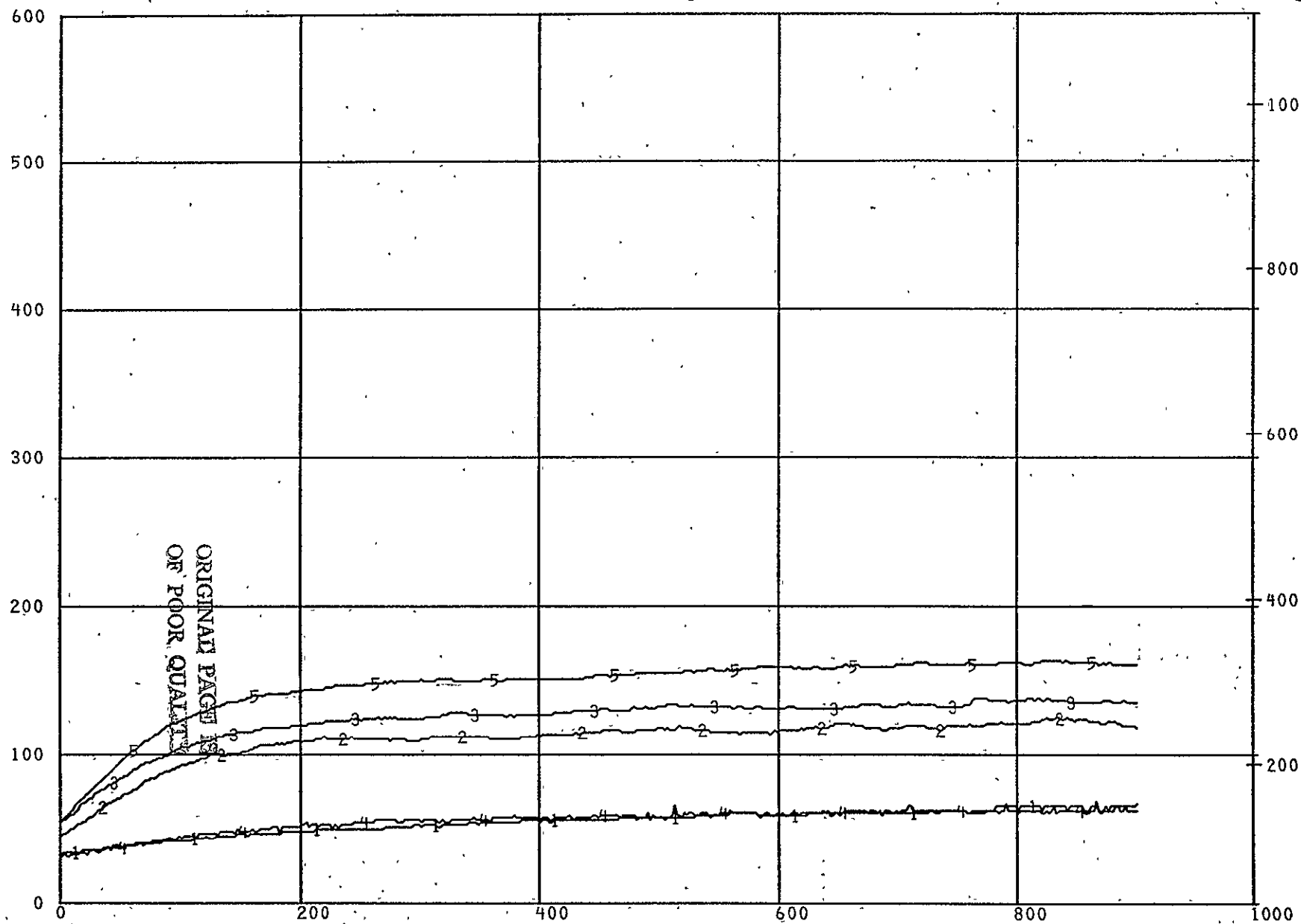
MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

TITLE
RELATIVE TIME IN SEC

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

287



MEAS. NUMBER	CHANNEL ASGN.	TITLE	RANGE	UNITS	GRID-SYM
\$ TC14	134		0 TO 600	DEG C	A1
\$ TC15	135		0 TO 600	DEG C	A2
\$ TC16	136		0 TO 600	DEG C	A3
\$ TC17	137		0 TO 600	DEG C	A4
\$ TC18	138		0 TO 600	DEG C	A5

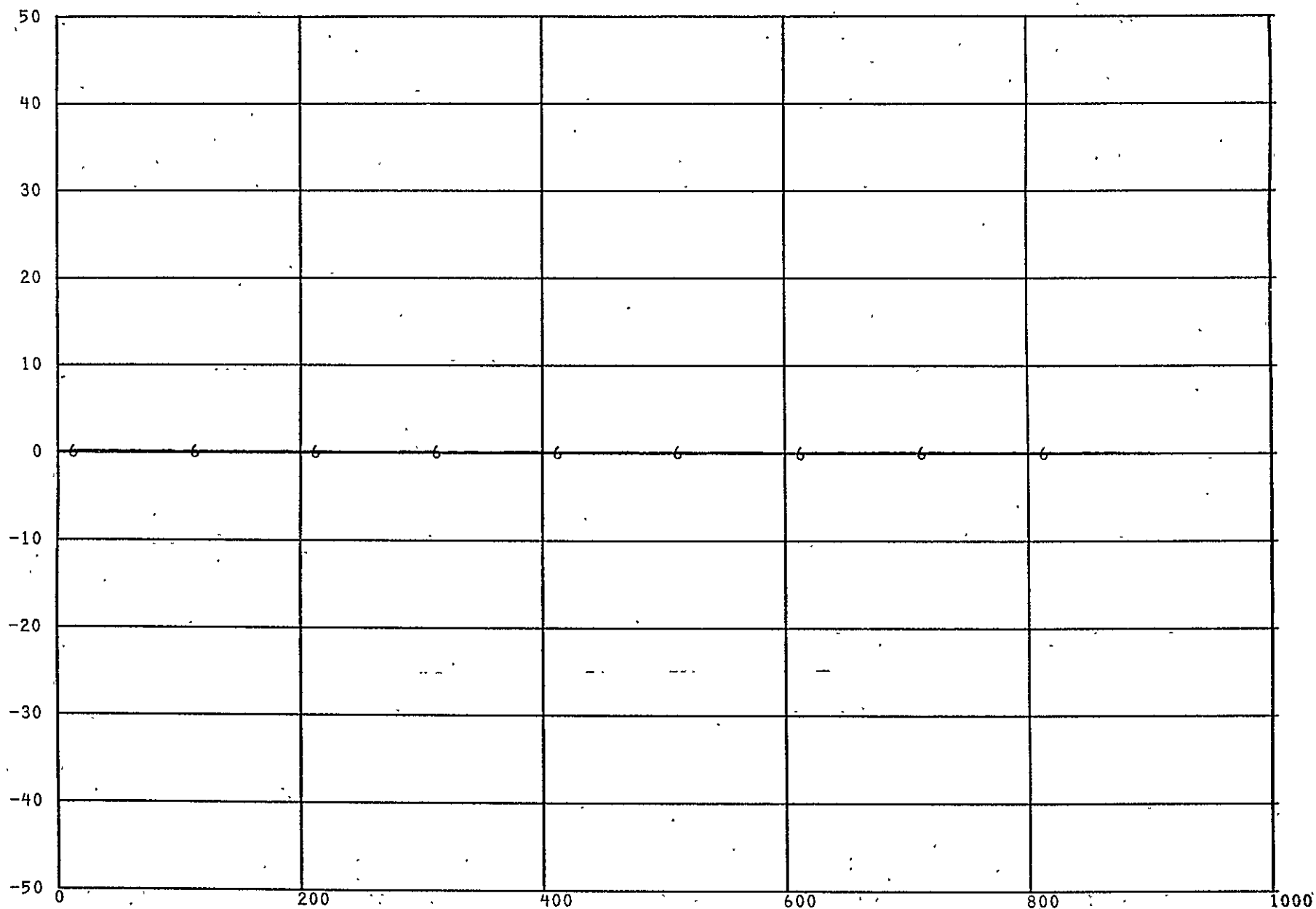
TEST ID 840288 095000

ST26B

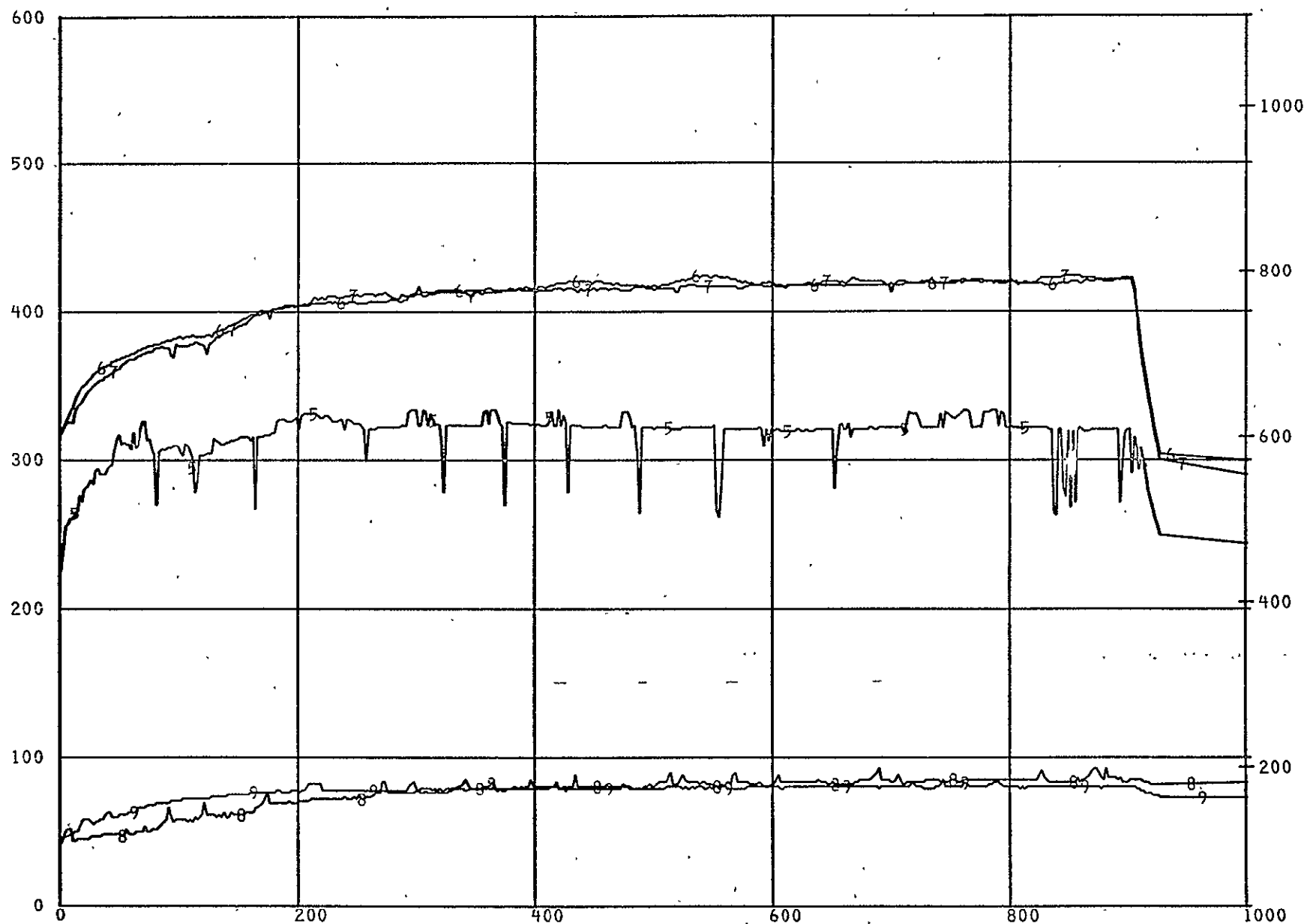
PLOT NO

6 - 1

REFERENCE TIME 08 55 32.000

MEAS. NUMBER
PRESSCHANNEL ASGN.
098TITLE
CABIN DELTA PRESSURERANGE
0.0 TO 20.0UNITS GRID-SYM
1N-H20 A6

289



MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

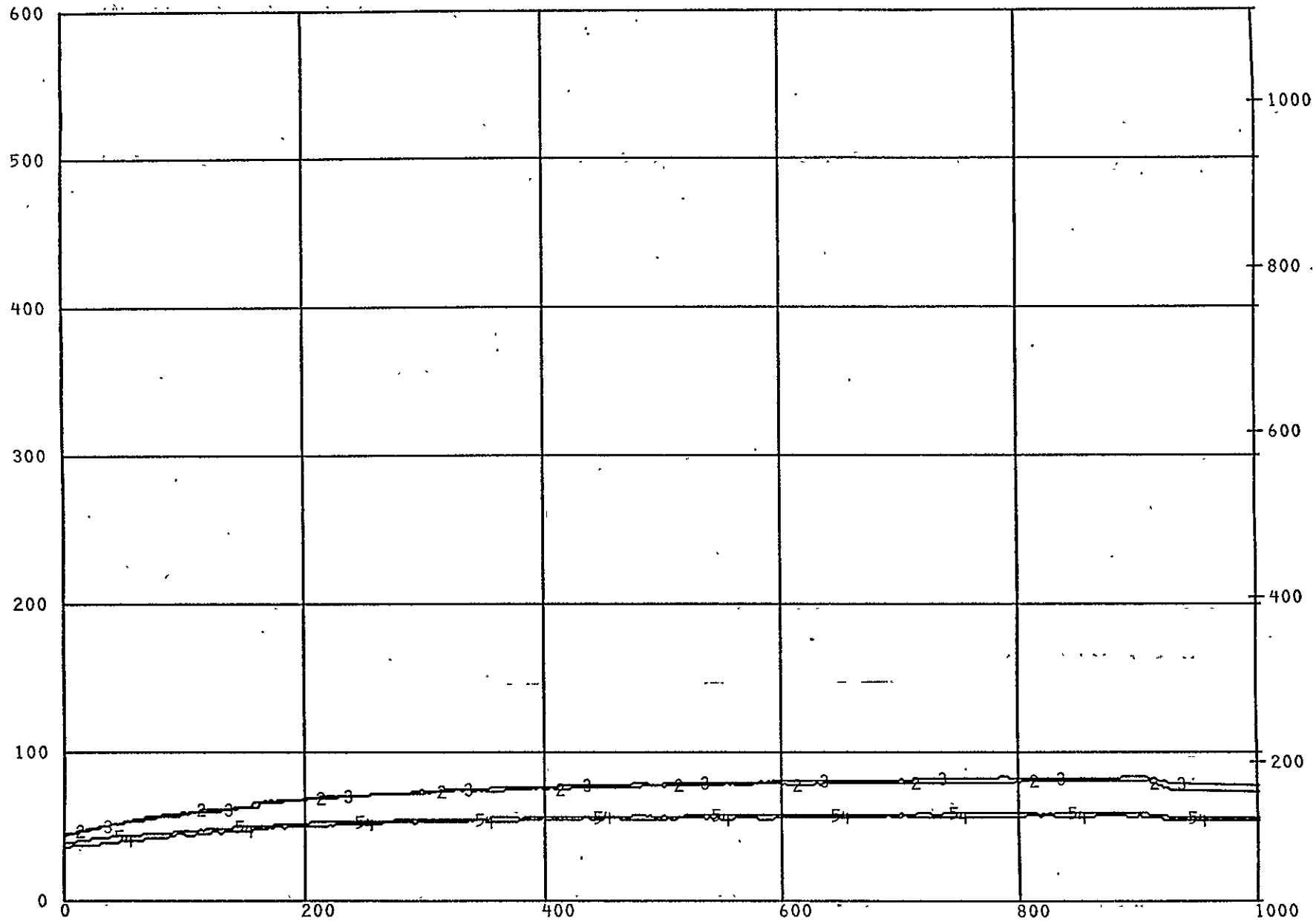
UNITS GRID-SYM
DEG C A5
DEG C A6
DEG C A7
DEG C A8
DEG C A9

TEST ID 840288 095000

ST26C

PLOT NO 3 - 1

REFERENCE TIME 09 21 02.00

DEG
F

MEAS. NUMBER CHANNEL ASGN.
\$ TC02 102
\$ TC03 103
\$ TC09 109
\$ TC08 108

TITLE
RELATIVE TIME IN SEC

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS GRID-SYM
DEG C A2
DEG C A3
DEG C A4
DEG C A5

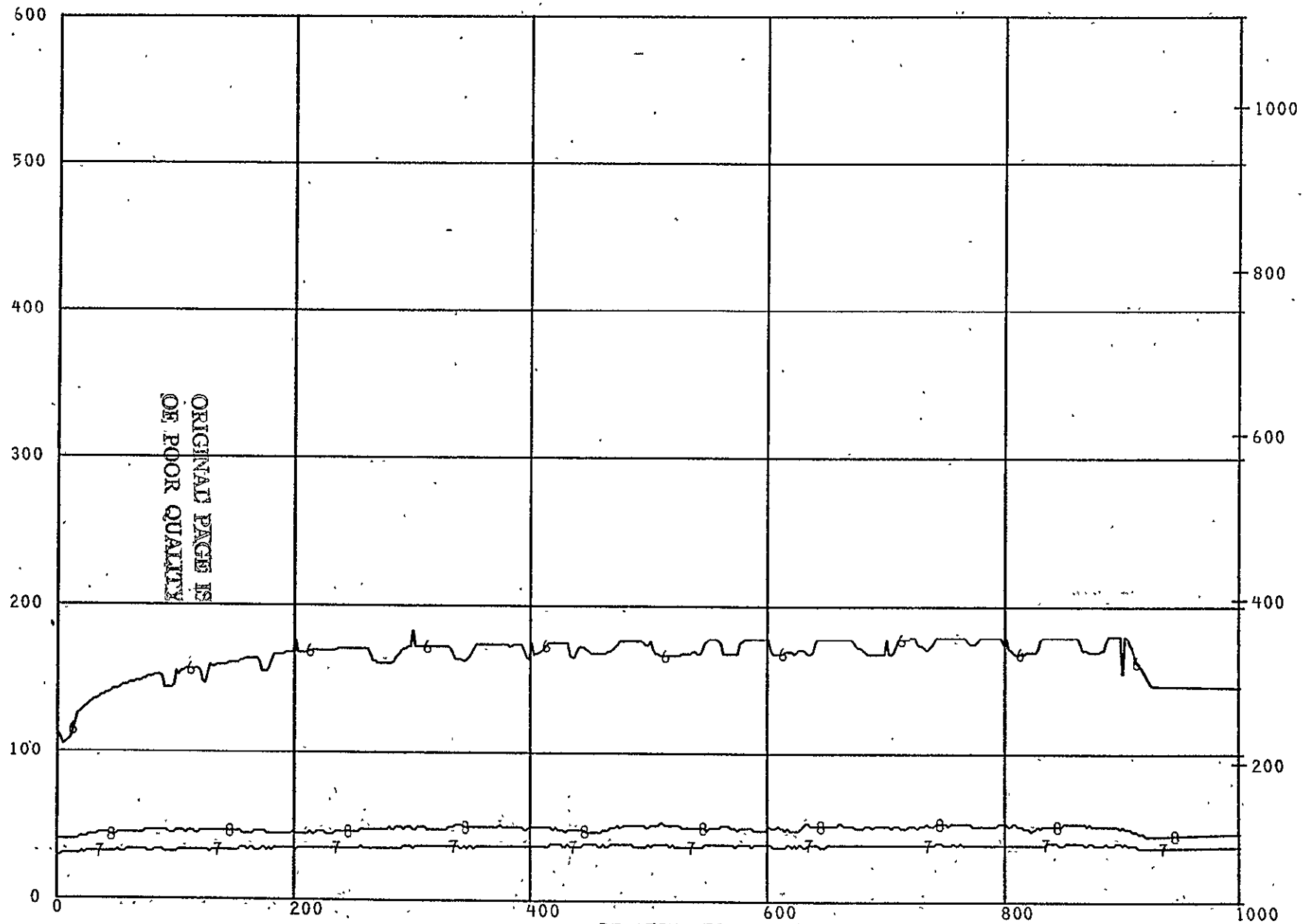
TEST ID 840288 095000

ST26C

PLOT NO

4 - 1

REFERENCE TIME 09 21 02.000

D
E
G
F

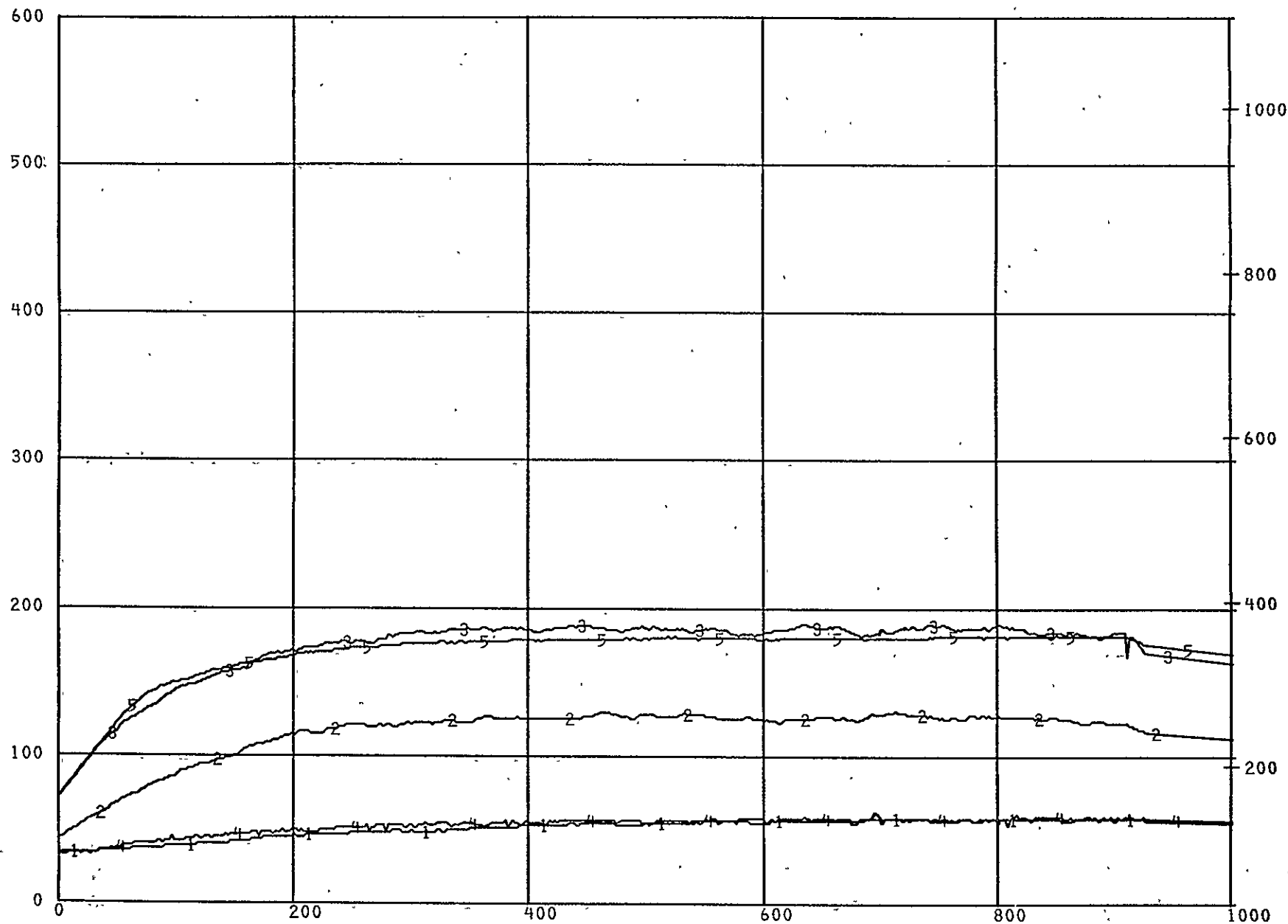
MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

292



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

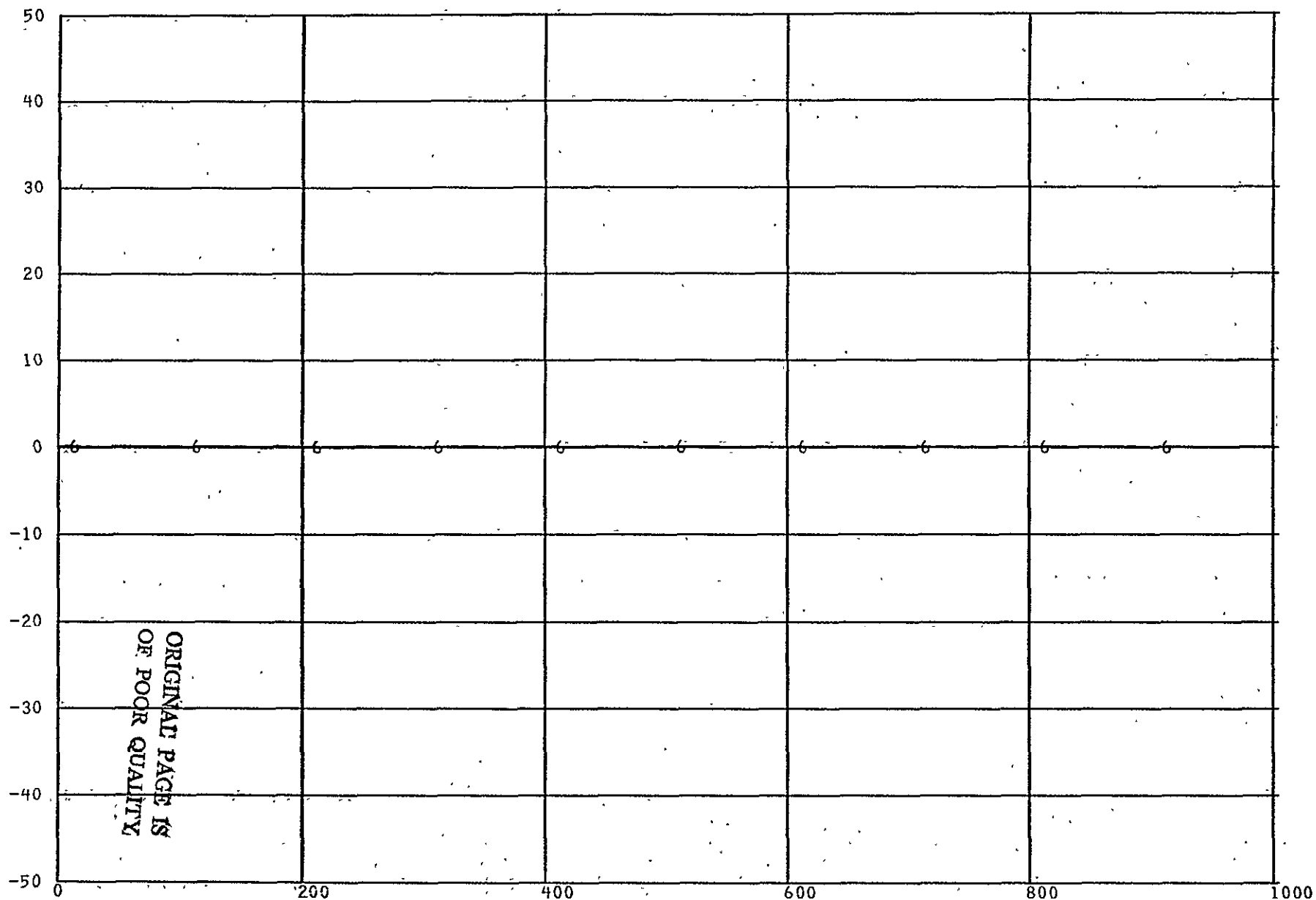
UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 095000

ST26C

PLOT NO 6 - 1

REFERENCE TIME 09 21 02.000



MEAS. NUMBER
PRESS

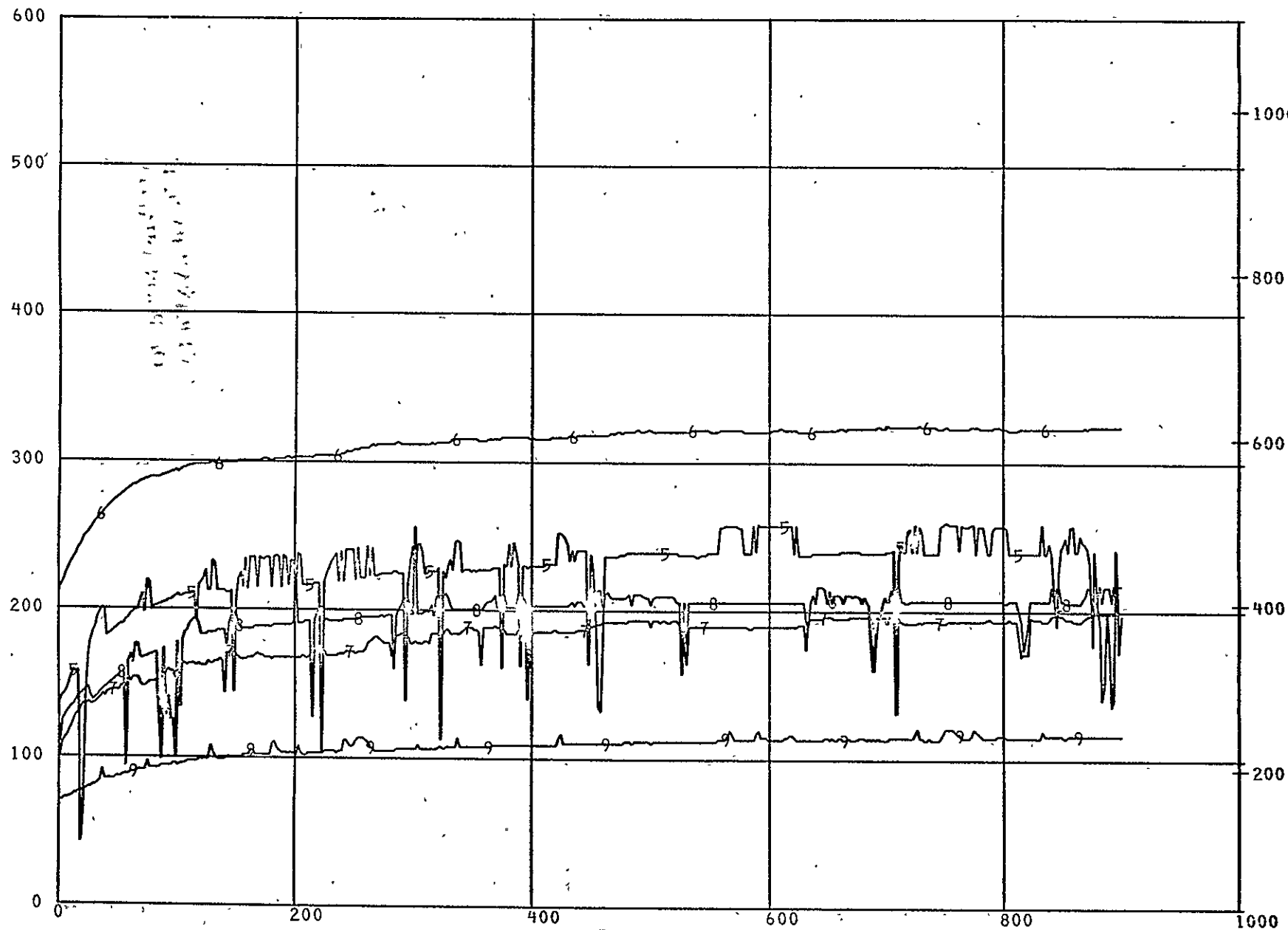
CHANNEL ASGN.
098.

TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
1N-H20 A6

294



MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

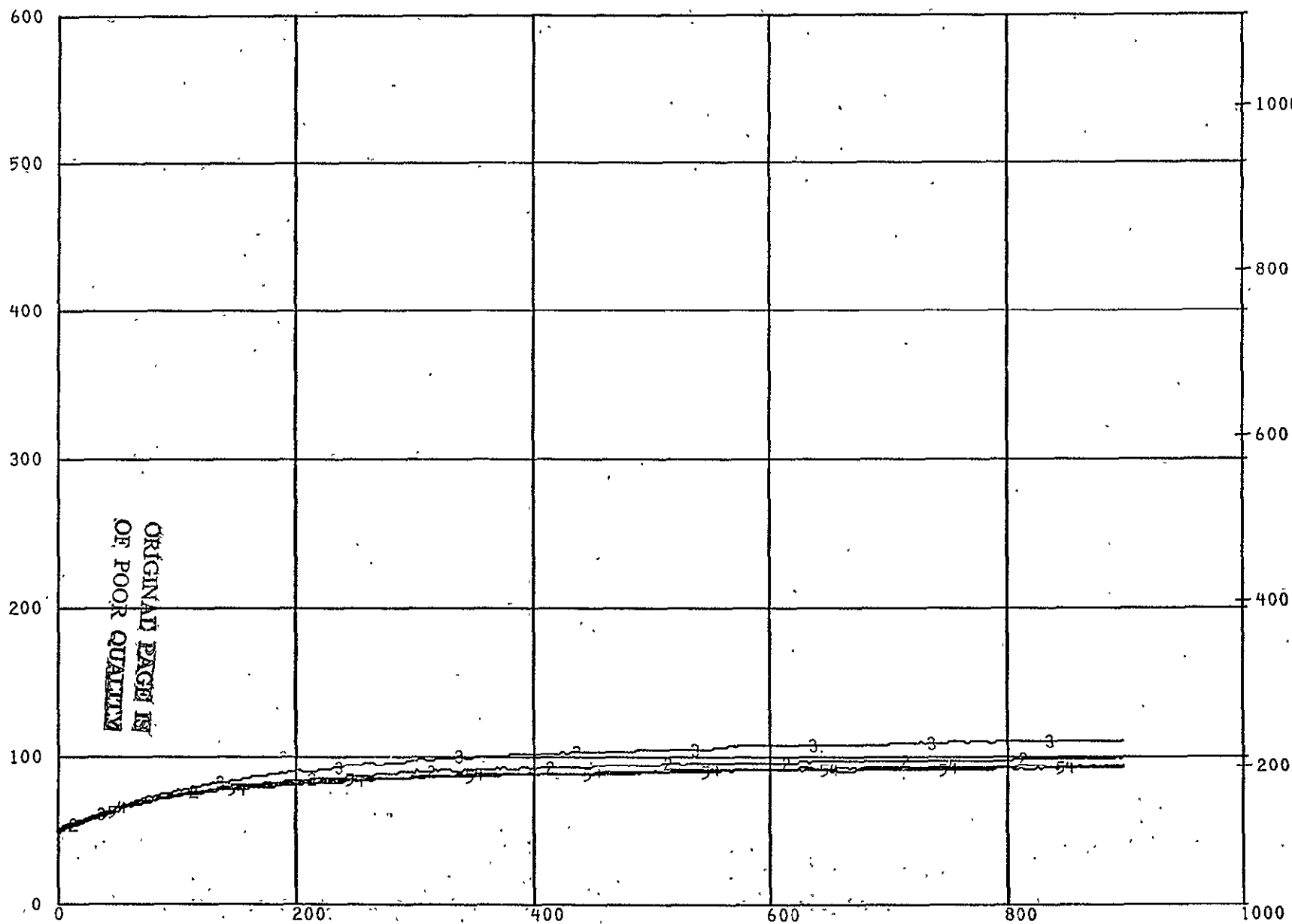
UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

TEST ID 840288 095000

ST27A

PLOT NO 3 - 1

REFERENCE TIME 10 00 34.000

D
E
G
F

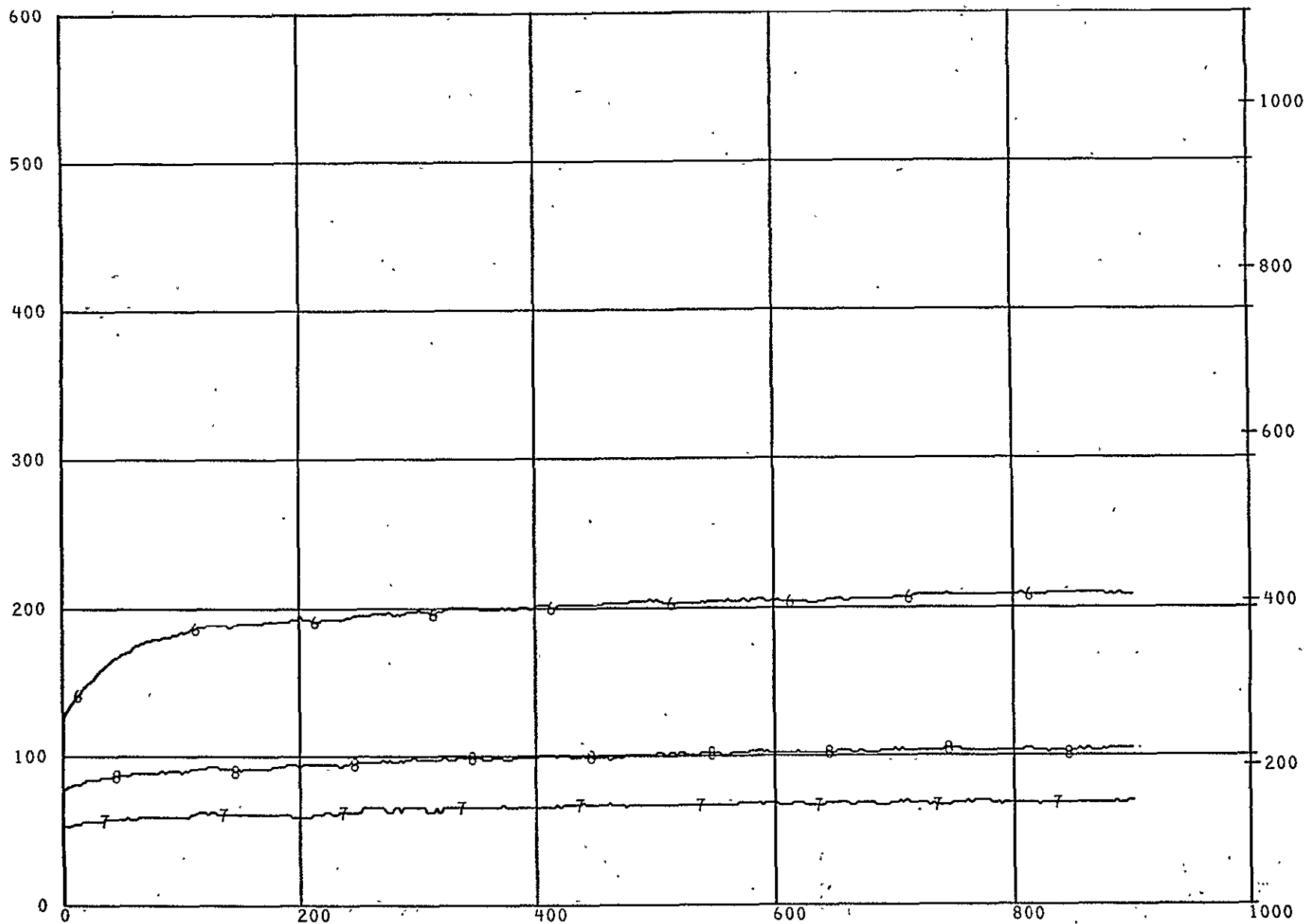
MEAS. NUMBER	CHANNEL ASGN.
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

296



MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

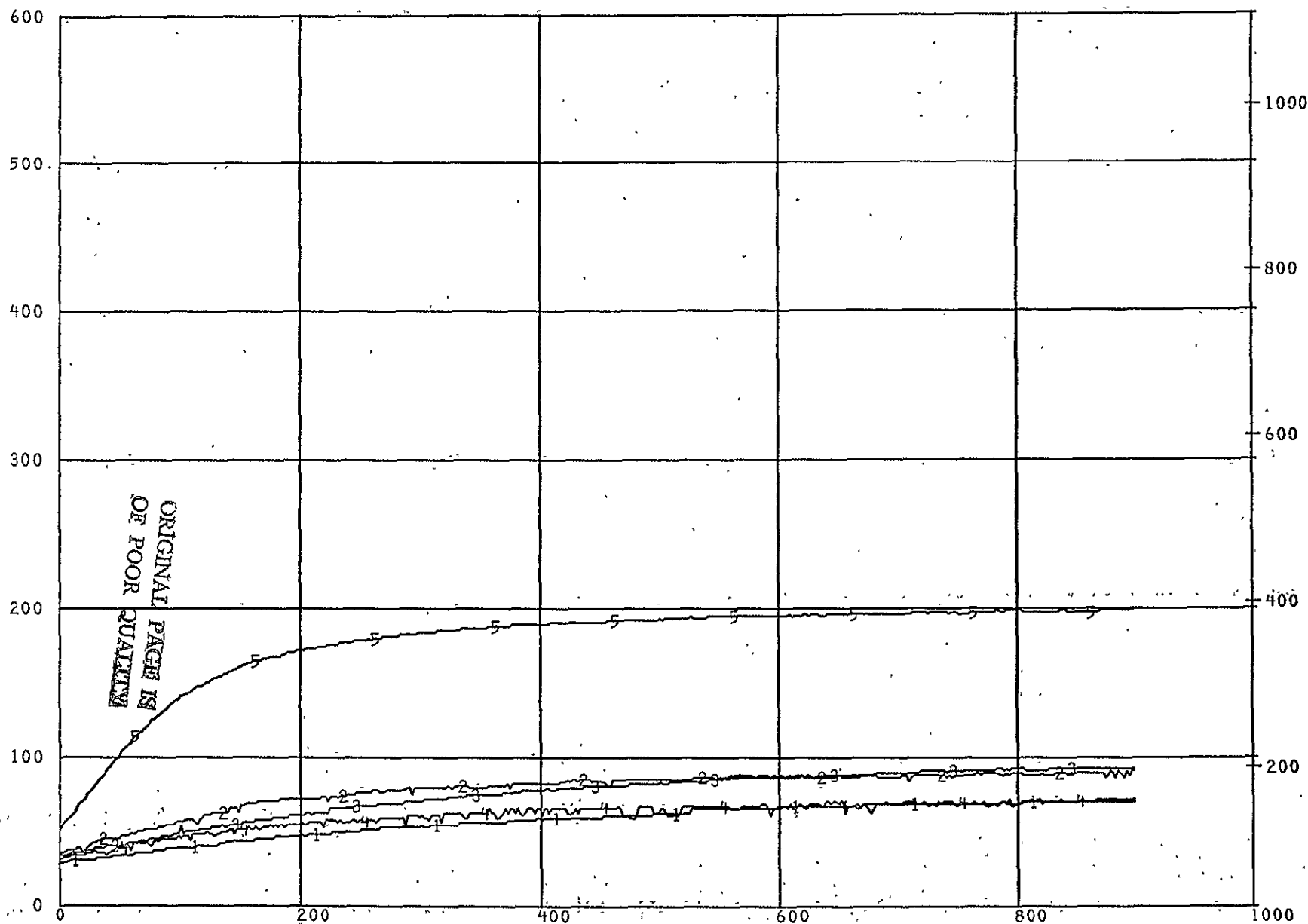
TEST ID 840288 095000

ST27A

PLOT NO

5 - 1

REFERENCE TIME 10 00 34.000

D
E
G
F

MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

TITLE
RELATIVE TIME IN SEC

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 500
0 TO 600

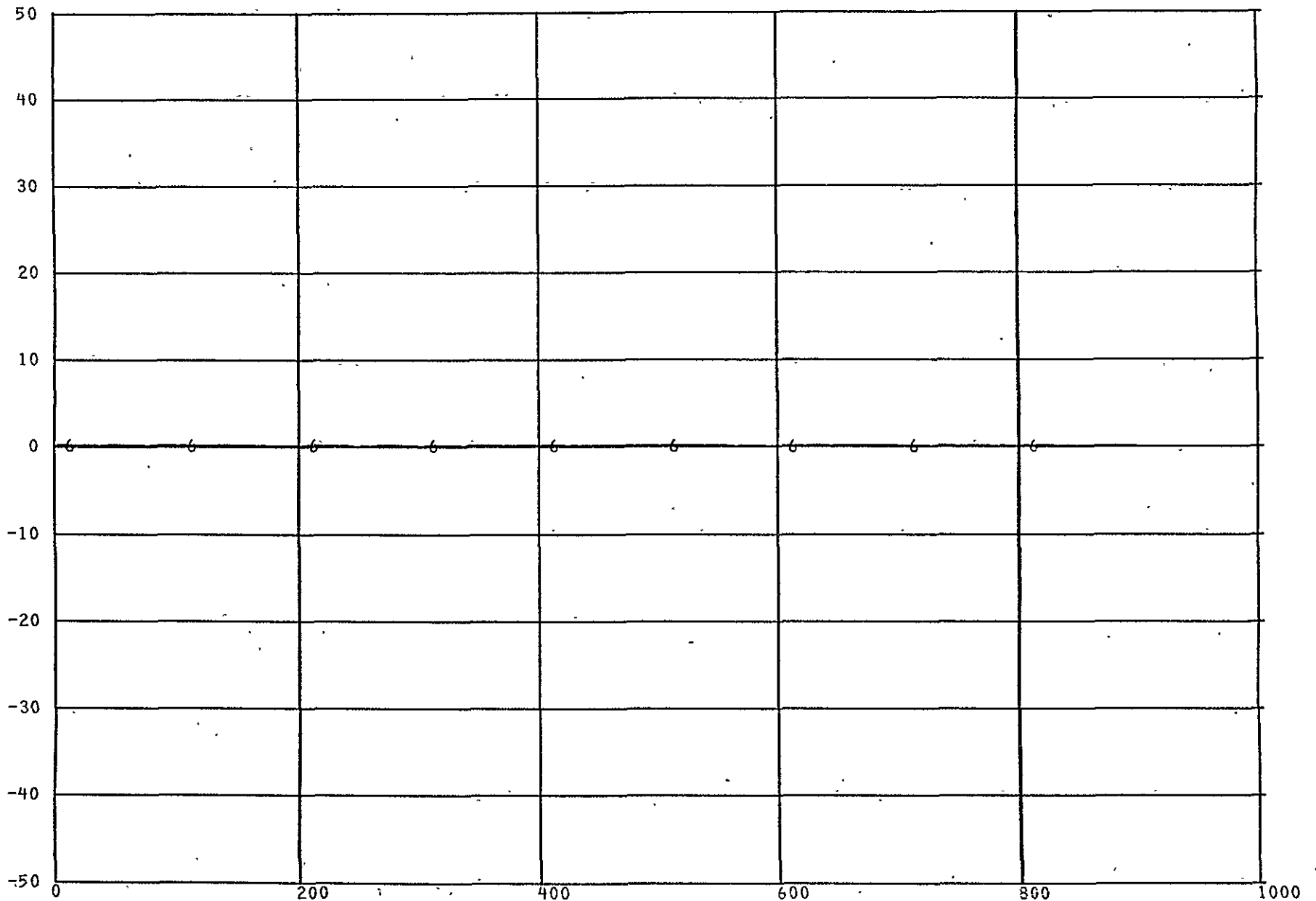
UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 095000

ST27A

PLOT NO 6 - 1

REFERENCE TIME 10 00 34.000



MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
IN-H20 A6

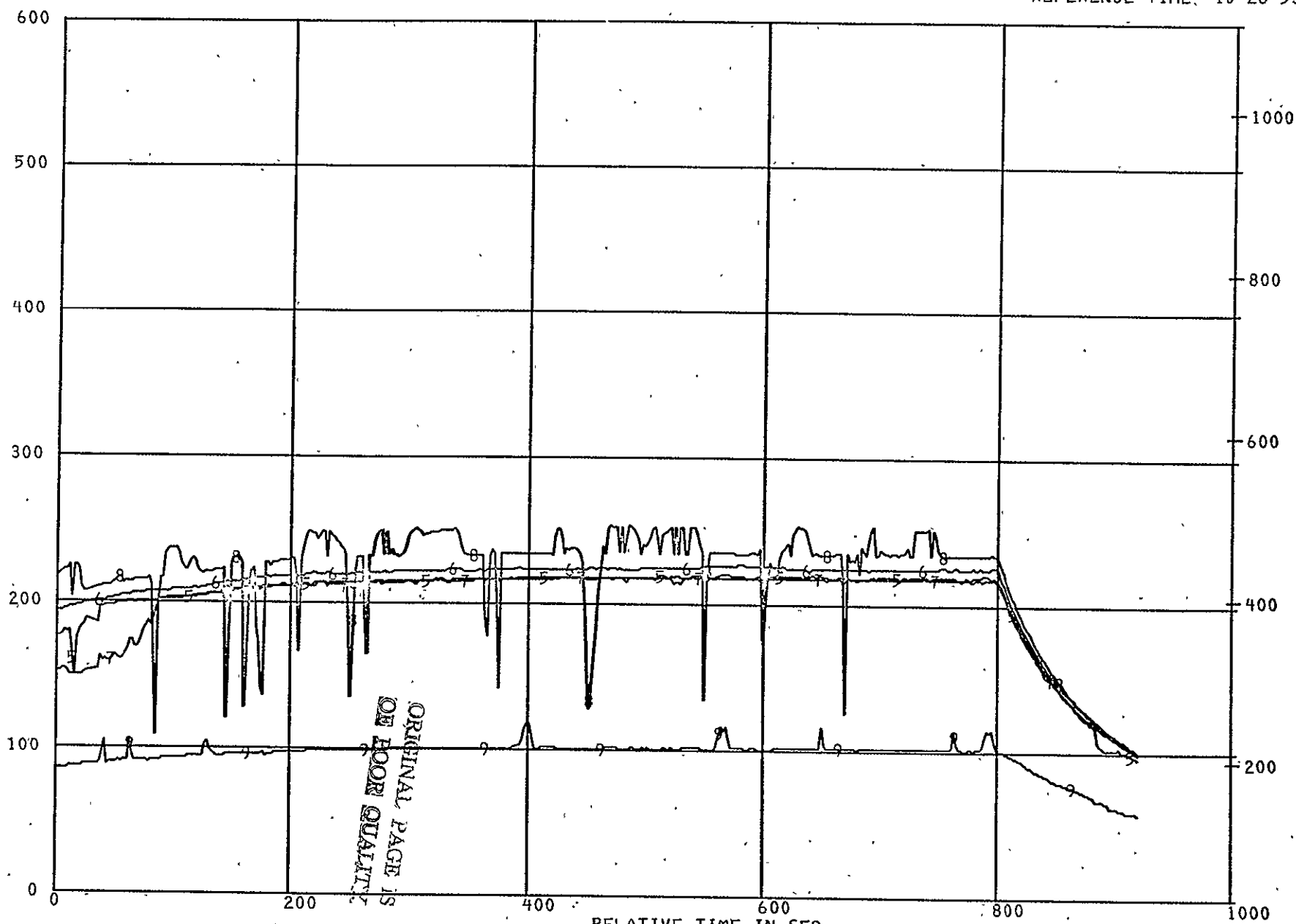
TEST ID 840288 095000

ST27B

PLOT NO

2 - 1

REFERENCE TIME, 10 28 53.000

D
E
G
F

MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

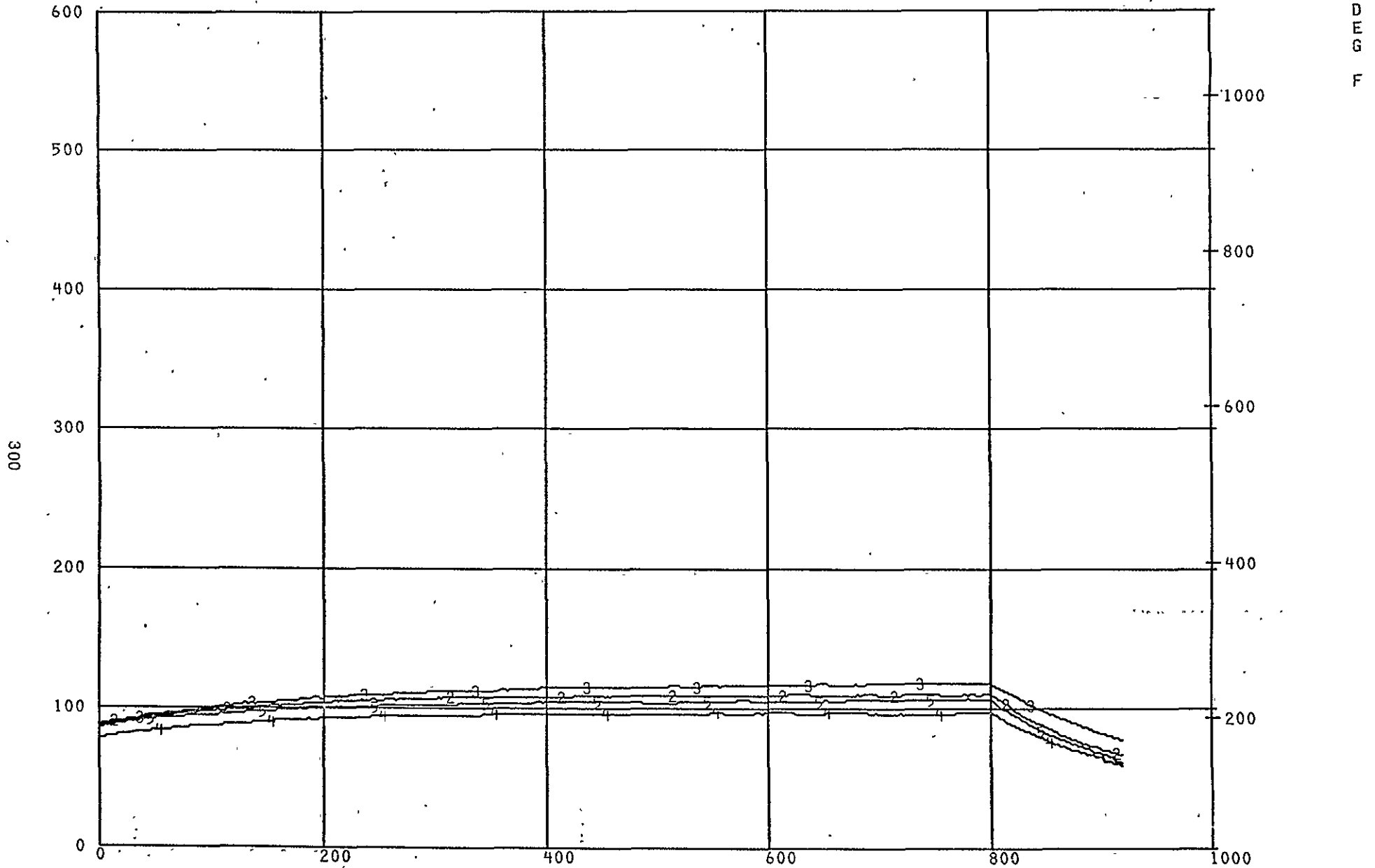
TEST ID 840288 095000

ST27B

PLOT NO

3 - 1

REFERENCE TIME 10 28 53.000



MEAS. NUMBER	CHANNEL ASGN.
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600

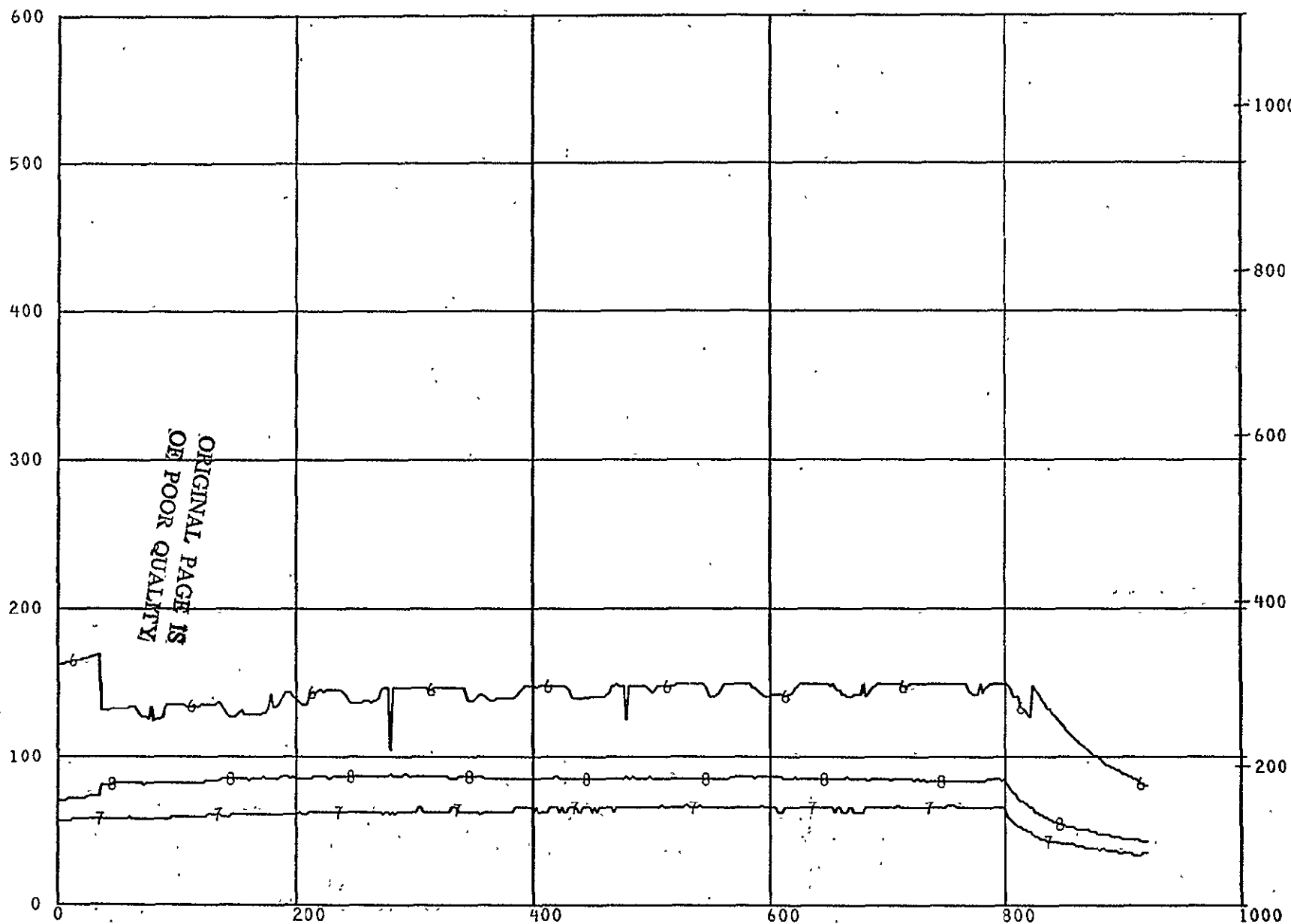
UNITS	GRID-SYM
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 095000

ST27B

PLOT NO 4 - 1

REFERENCE TIME 10 28 53.000

D
E
G
F

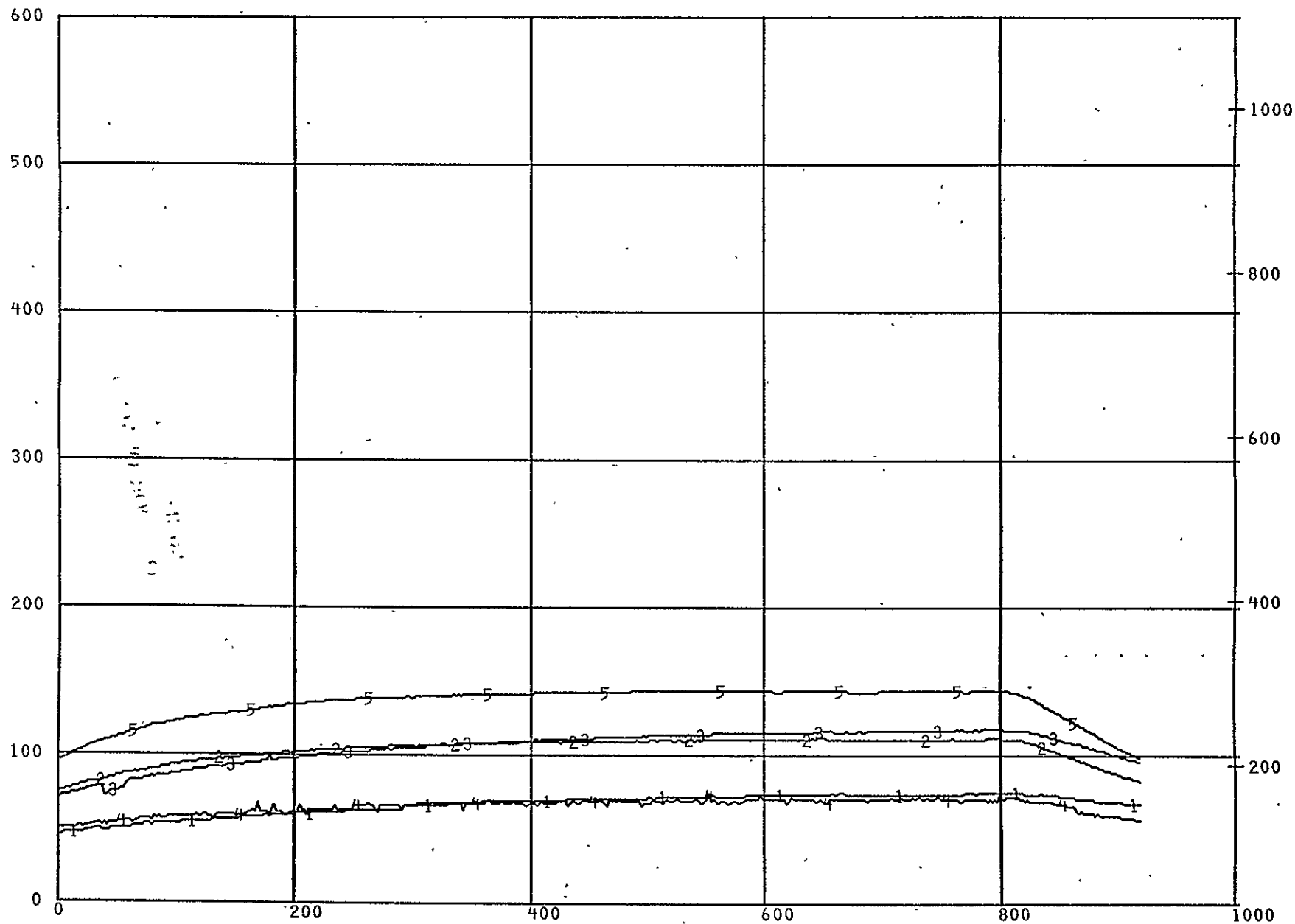
MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

302



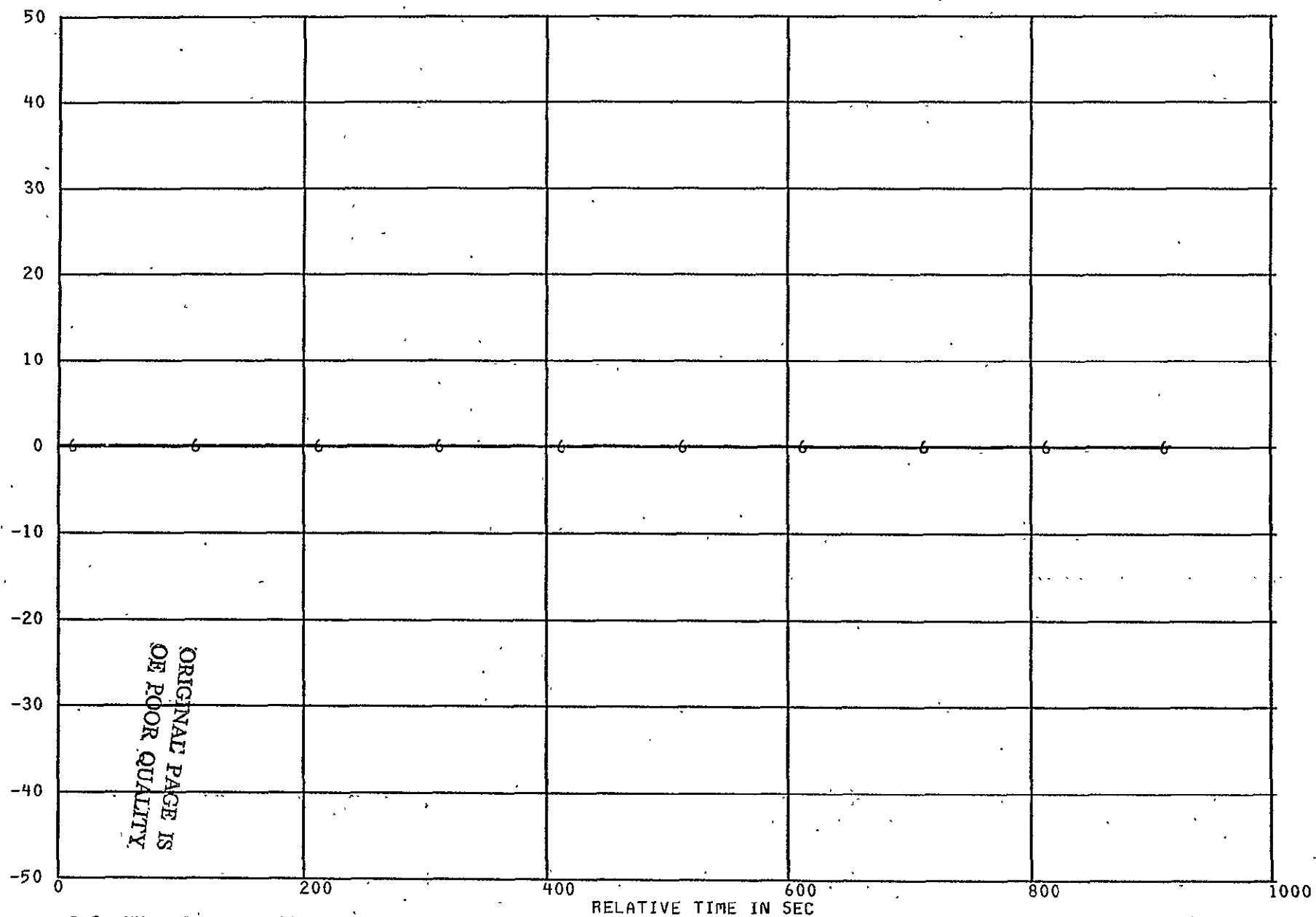
MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

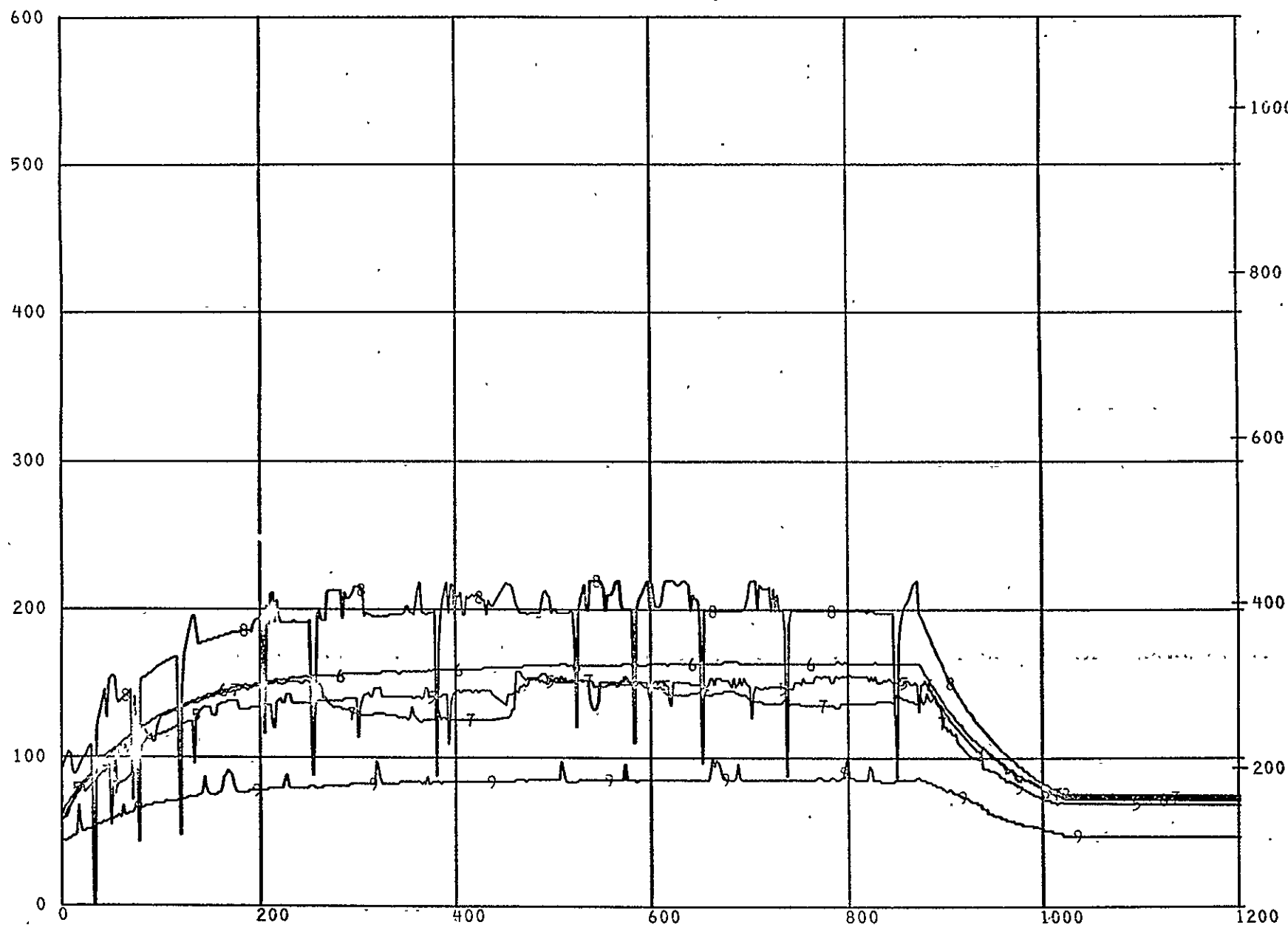
REFERENCE TIME 10 28 53.000



UNITS GRID-SYM
1N-H20 A6

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304

RELATIVE TIME IN SEC
TITLE

RANGE

UNITS

GRID-SYM

MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

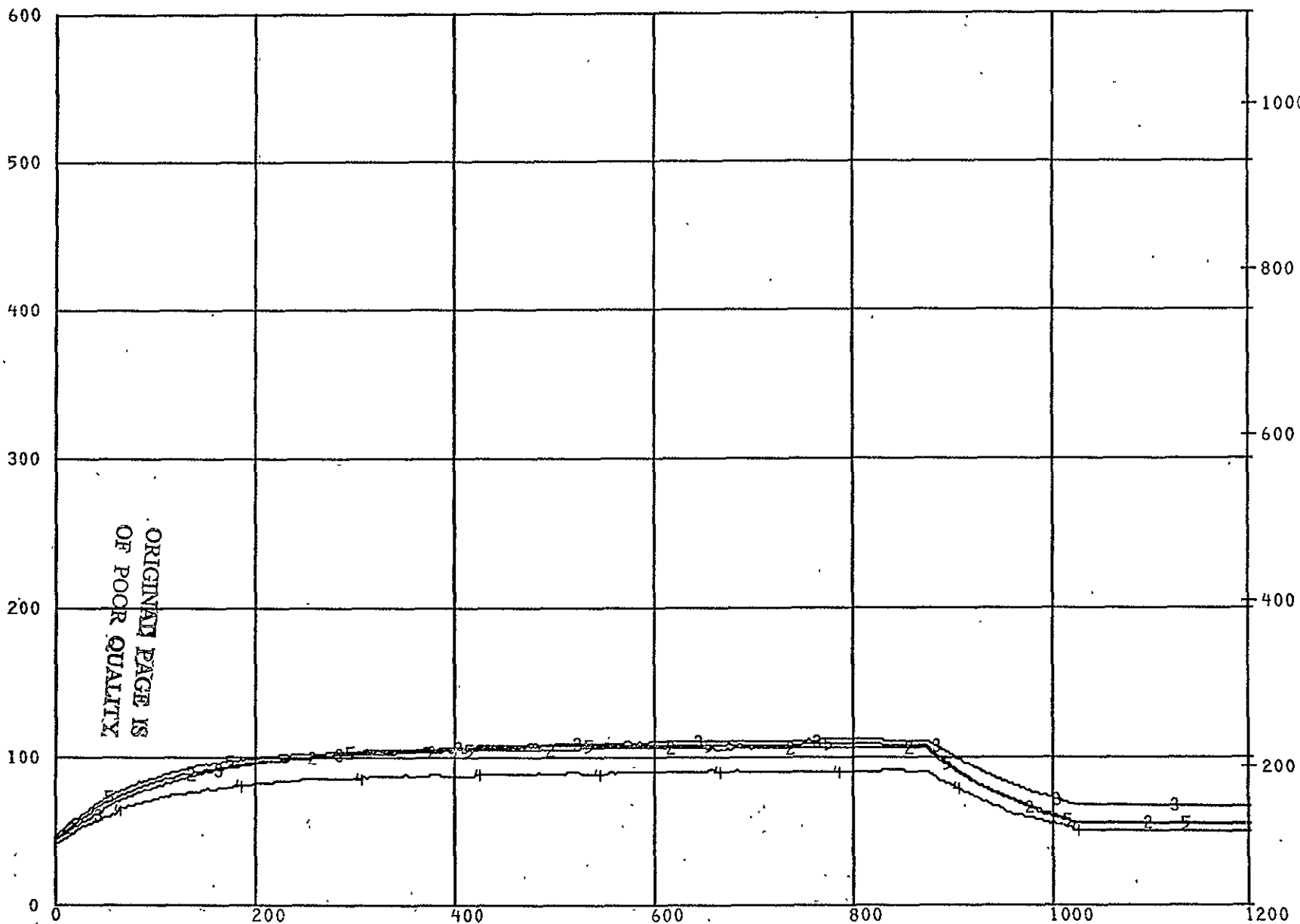
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

TEST ID 840288 095000

ST27C

PLOT NO 3 - 1

REFERENCE TIME 10 54 24.000



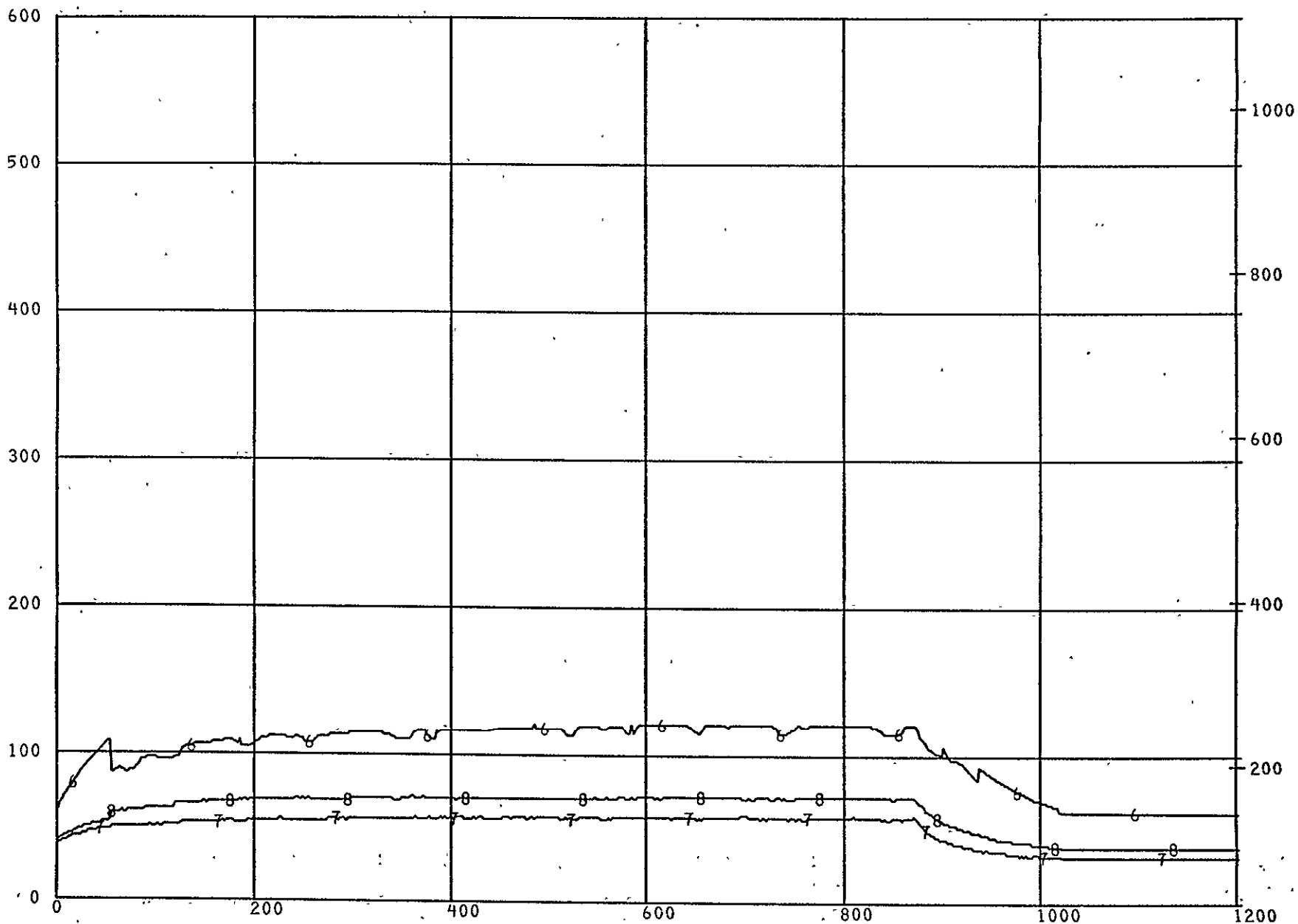
MEAS. NUMBER	CHANNEL ASGN.
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

TITLE
RELATIVE TIME IN SEC

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

306



MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

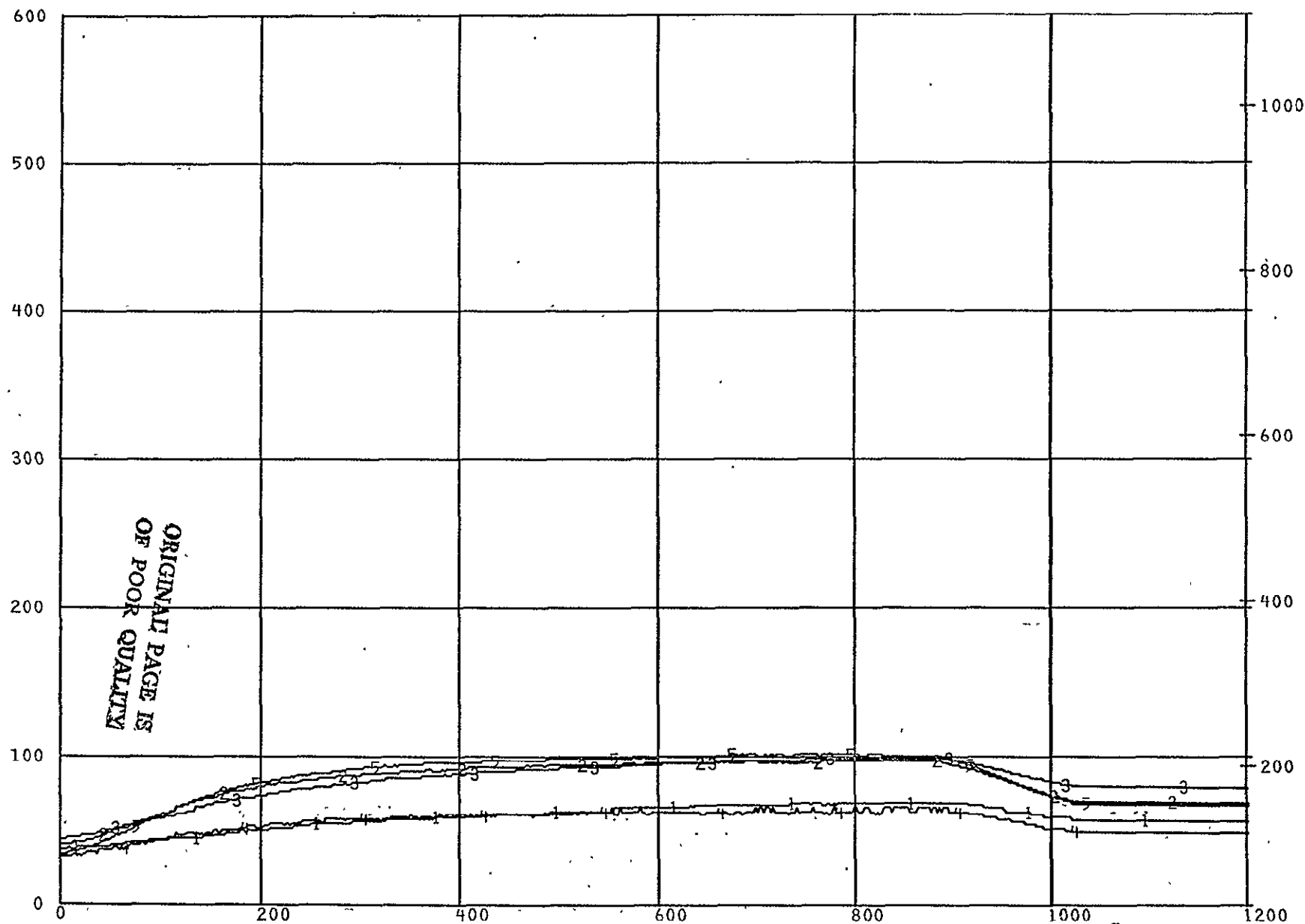
TEST ID 840288 095000

ST27C

PLOT NO 5 - 1

REFERENCE TIME 10 54 24.000

307



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

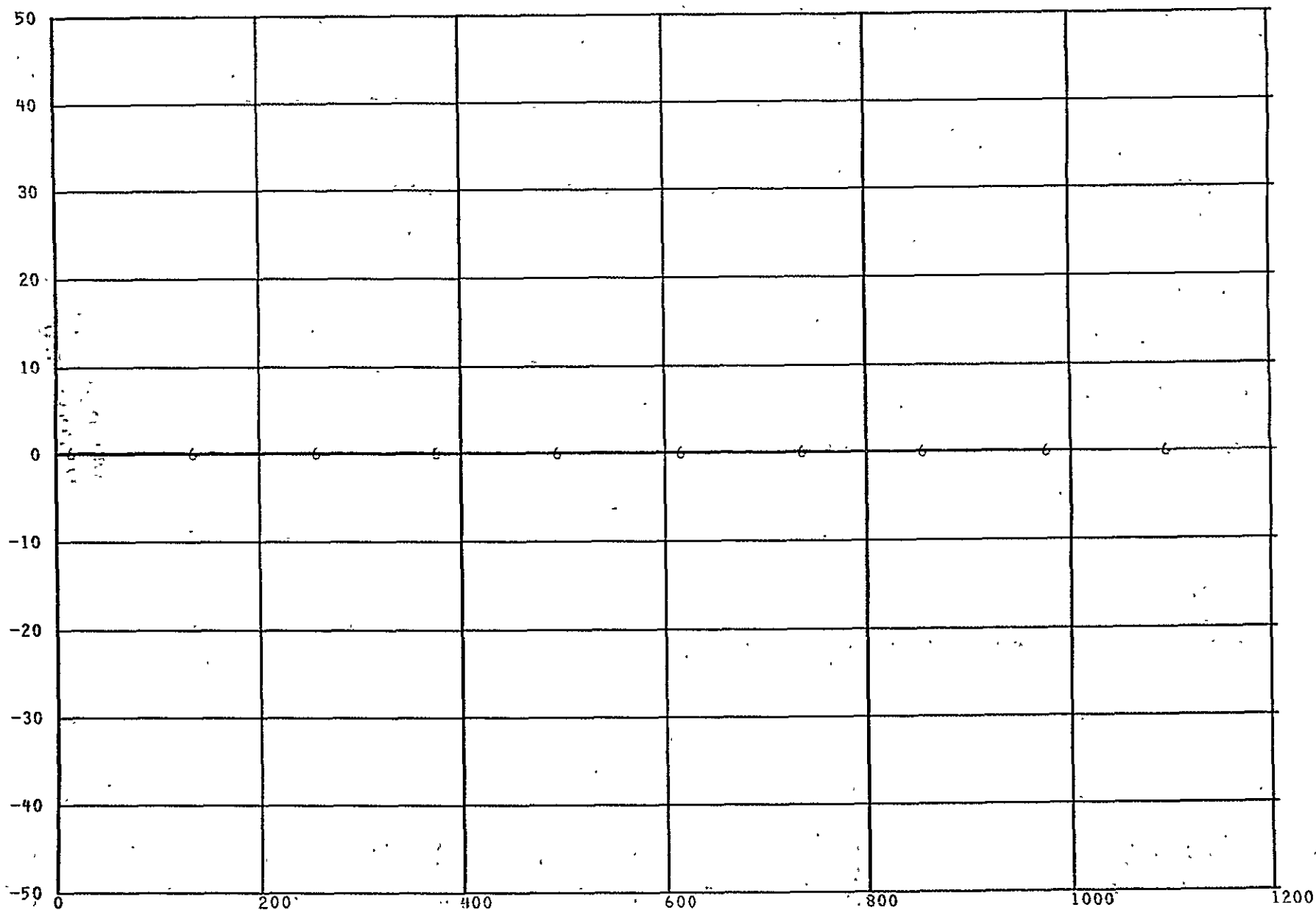
UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 095000

ST27C

PLOT NO 6 - 1

REFERENCE TIME 10 54 24.000

MEAS. NUMBER
PRESS.CHANNEL ASGN.
098RELATIVE TIME IN SEC
TITLE
CABIN DELTA PRESSURERANGE
0.0 TO 20.0UNITS GRID-SYM
1N-H20 A6

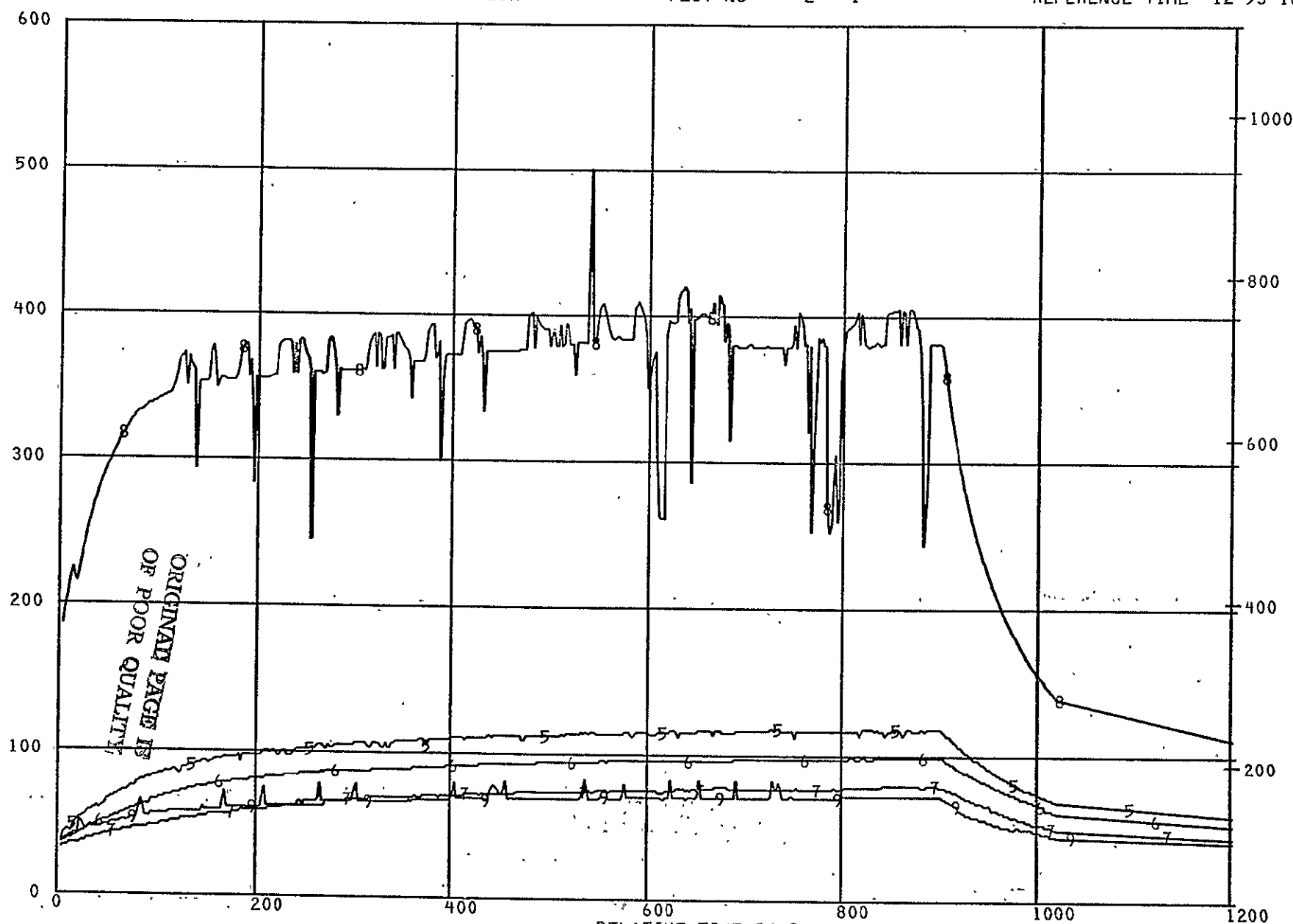
TEST ID 840288 095000

ST28A

PLOT NO 2 - 1

REFERENCE TIME 12 53 16.000

309



MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

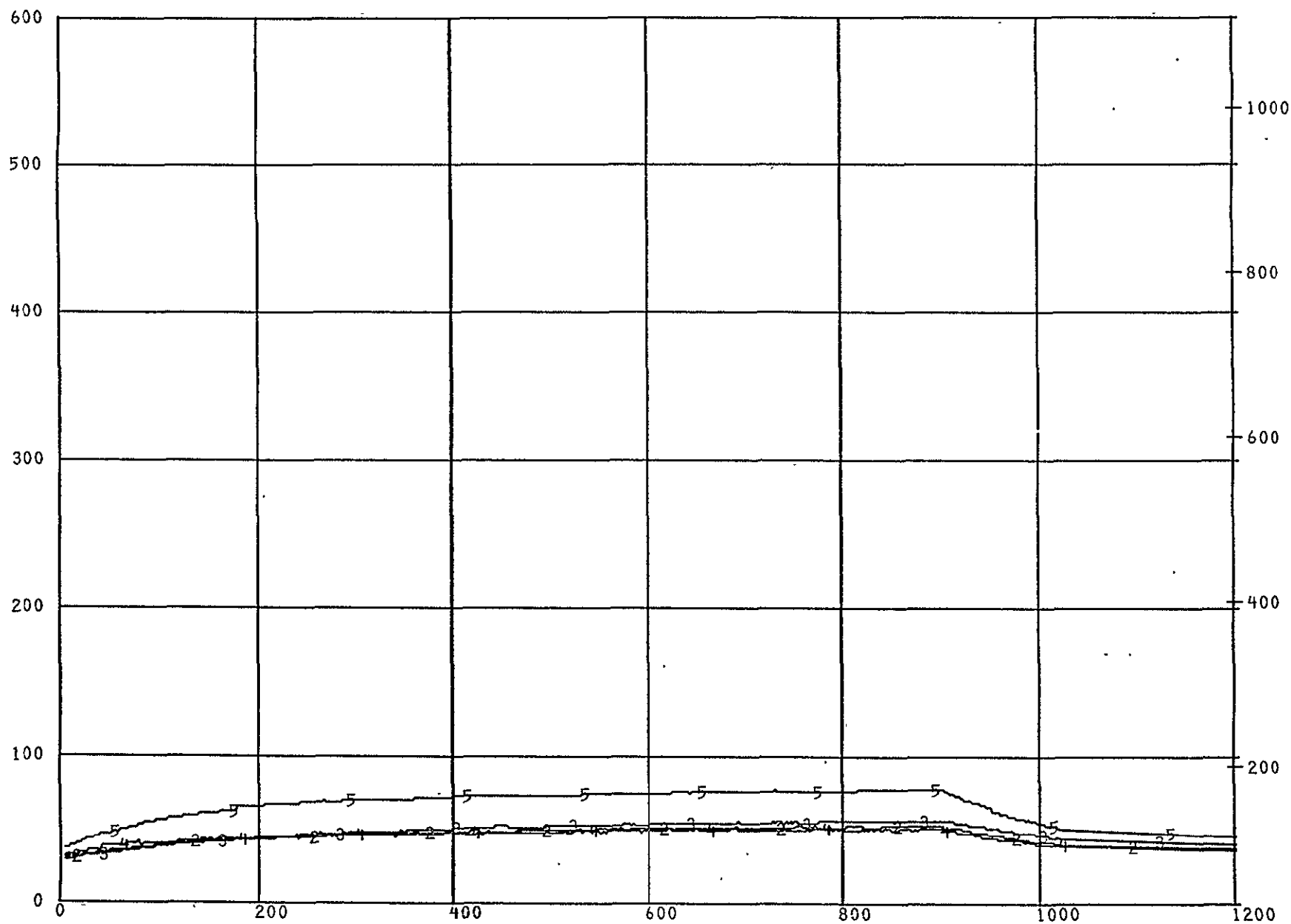
TEST ID 840288 095000

ST28A

PLOT NO 3 - 1

REFERENCE TIME 12 53 16.000

310



MEAS. NUMBER	CHANNEL ASGN.
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC	TITLE
----------------------	-------

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM.
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID: 840288 095000

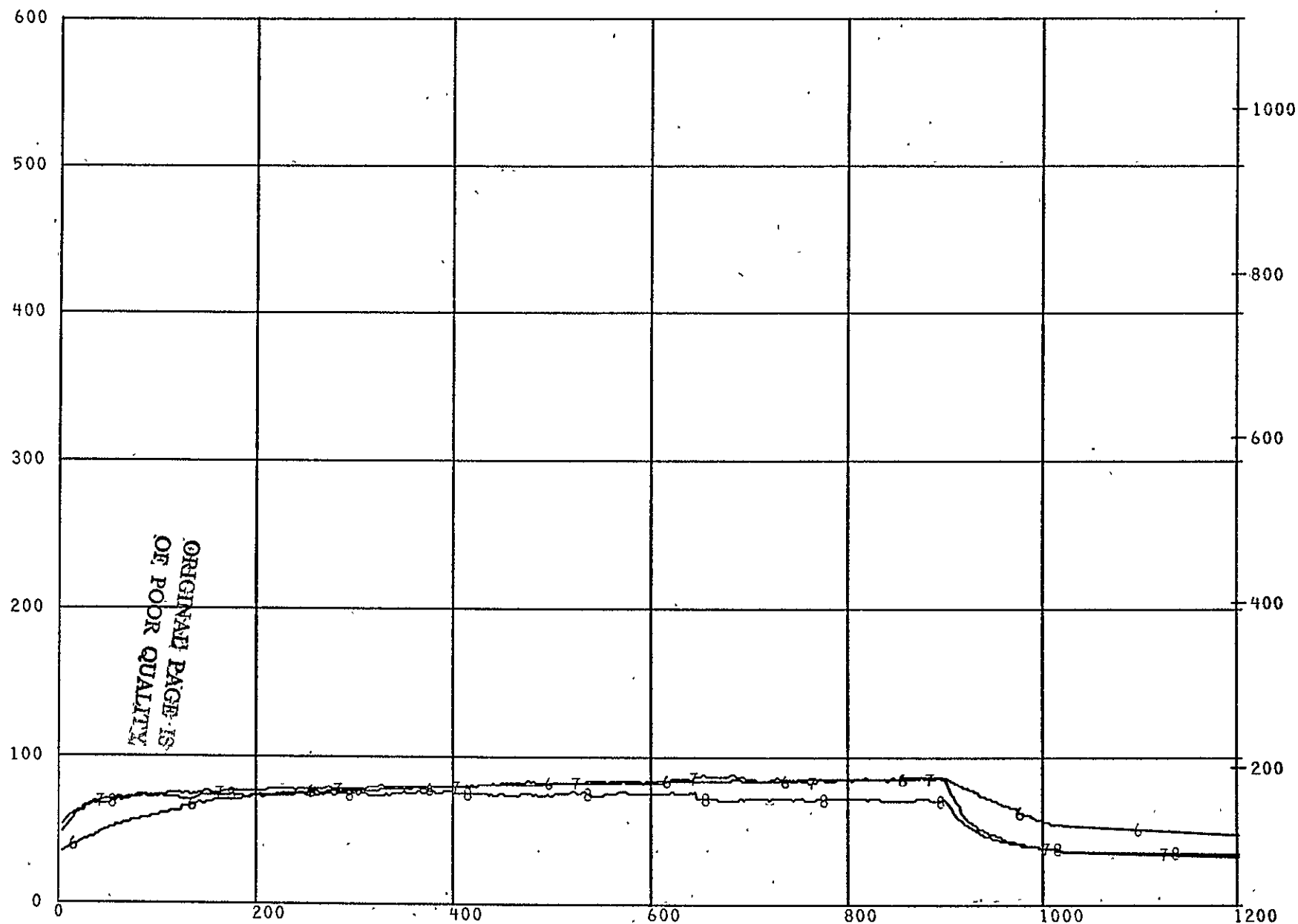
ST28A

PLOT NO

4 - 1

REFERENCE TIME 12 53 16.000

311



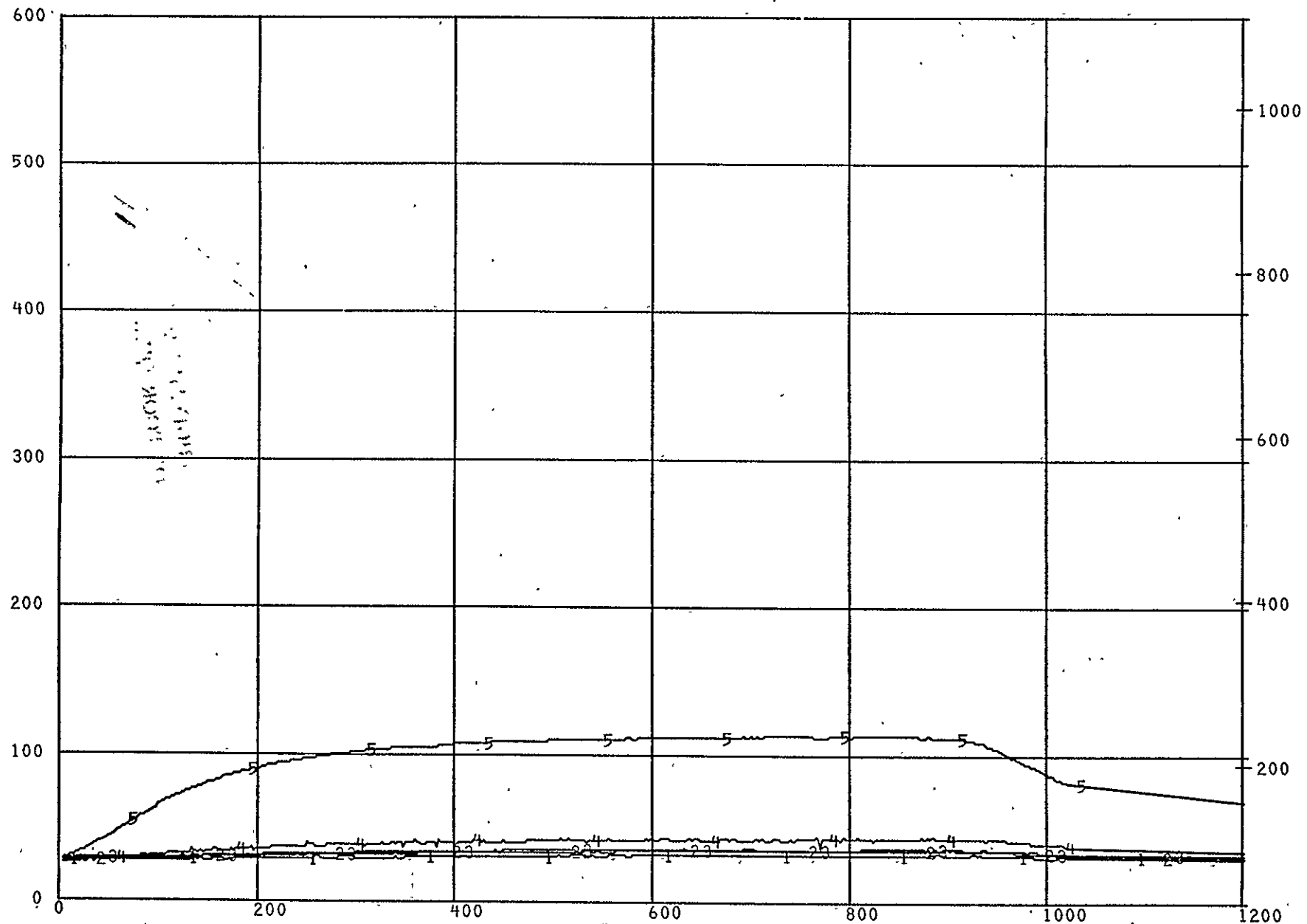
MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

312



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

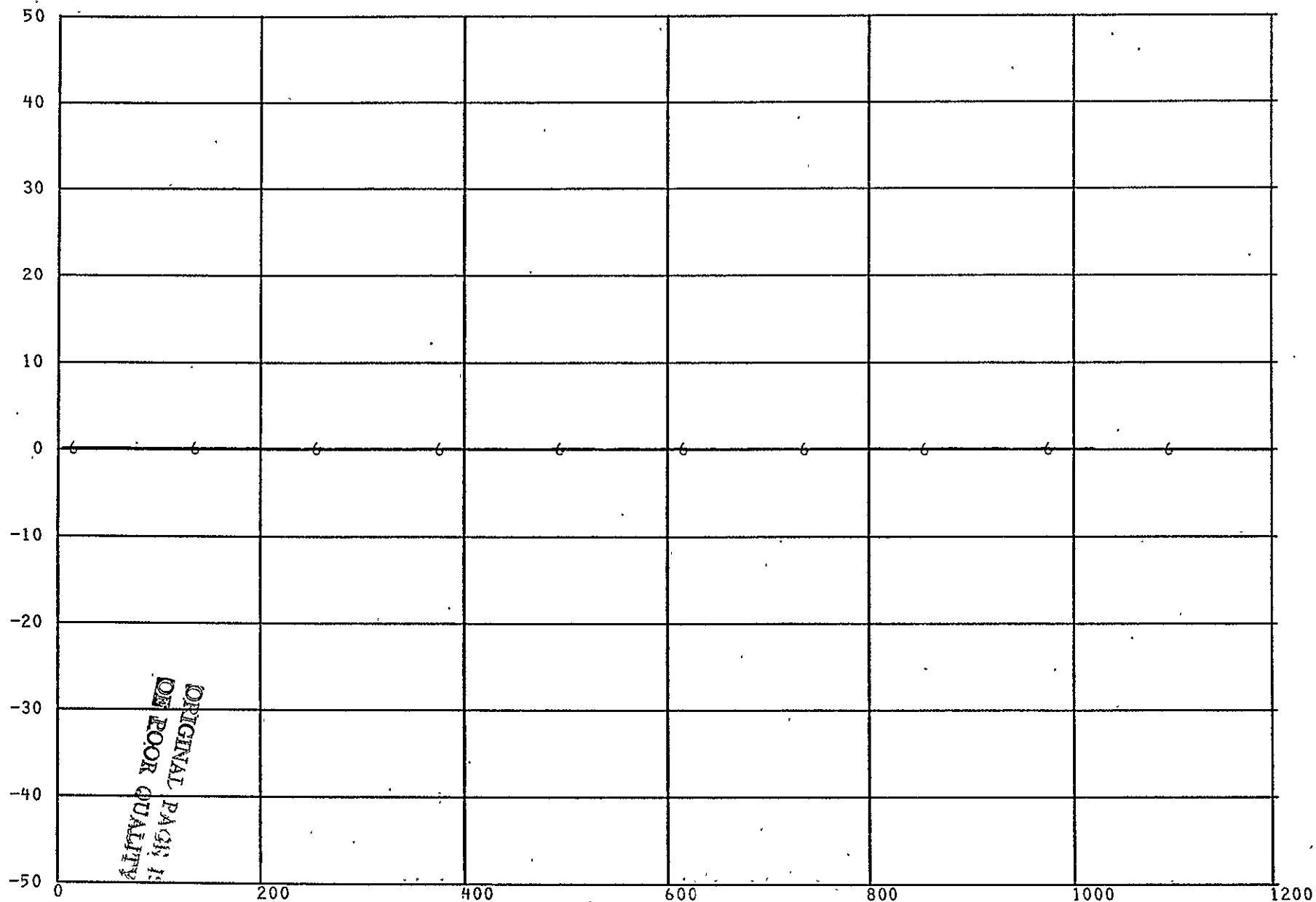
UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 095000

ST28A

PLOT NO 6 - 1

REFERENCE TIME 12 53 16.000



MEAS. NUMBER
PRESS

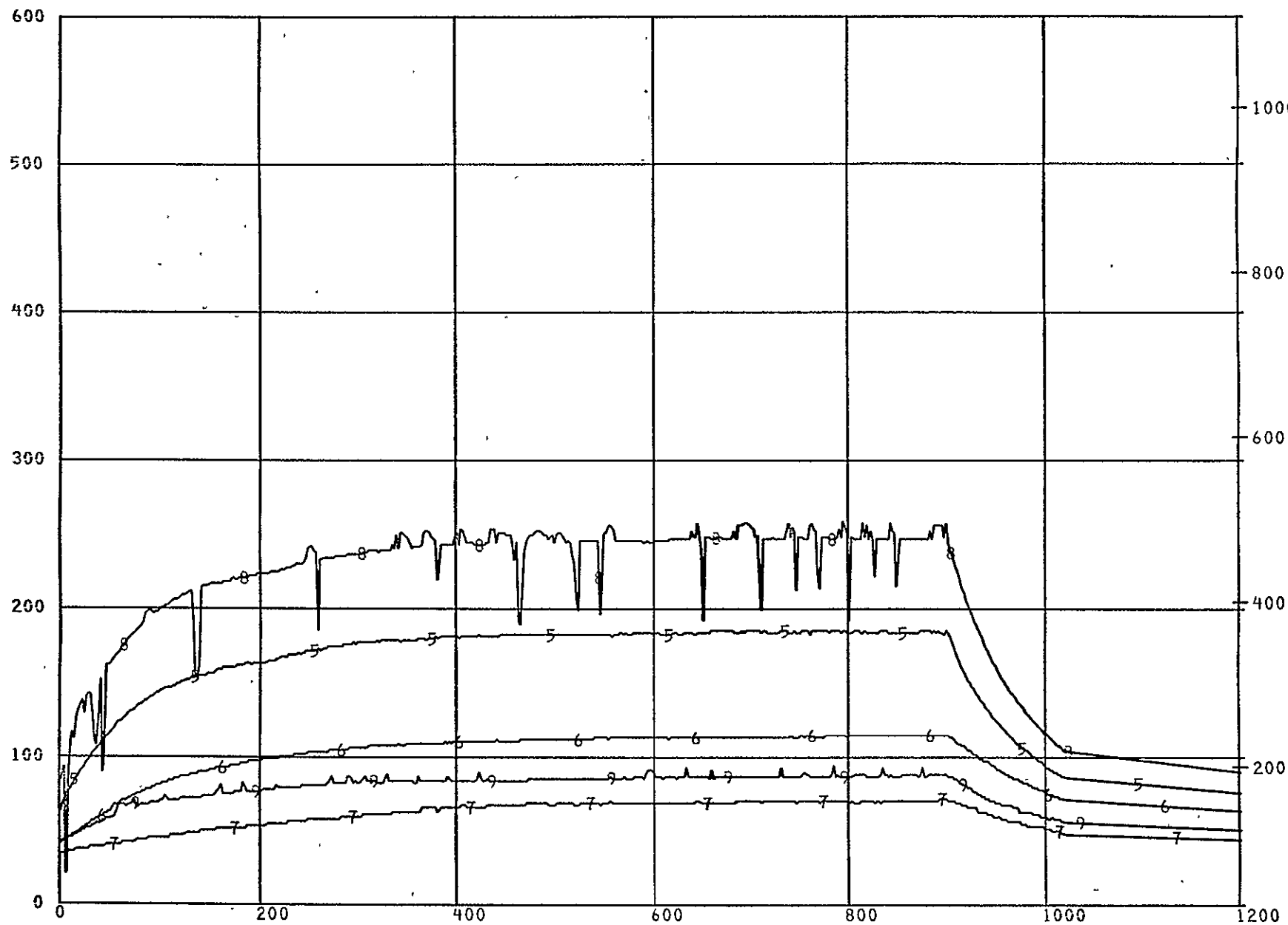
CHANNEL ASGN.
098

RELATIVE TIME IN SEC
TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SY
1N-H20 A6

314



MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

TEST ID 840288 095000

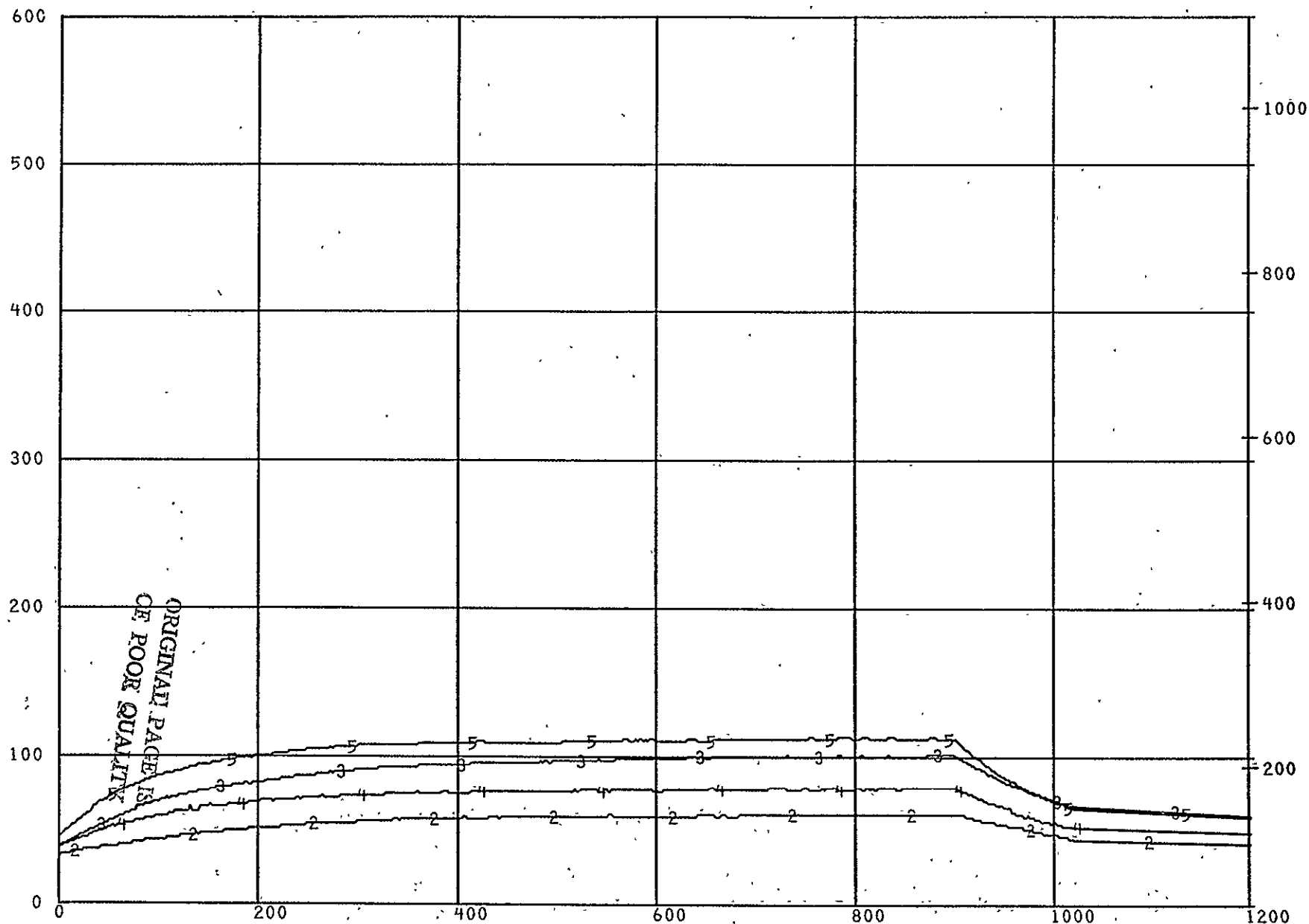
ST28B

PLOT NO

3 - 1

REFERENCE TIME 13 22 56.000

315



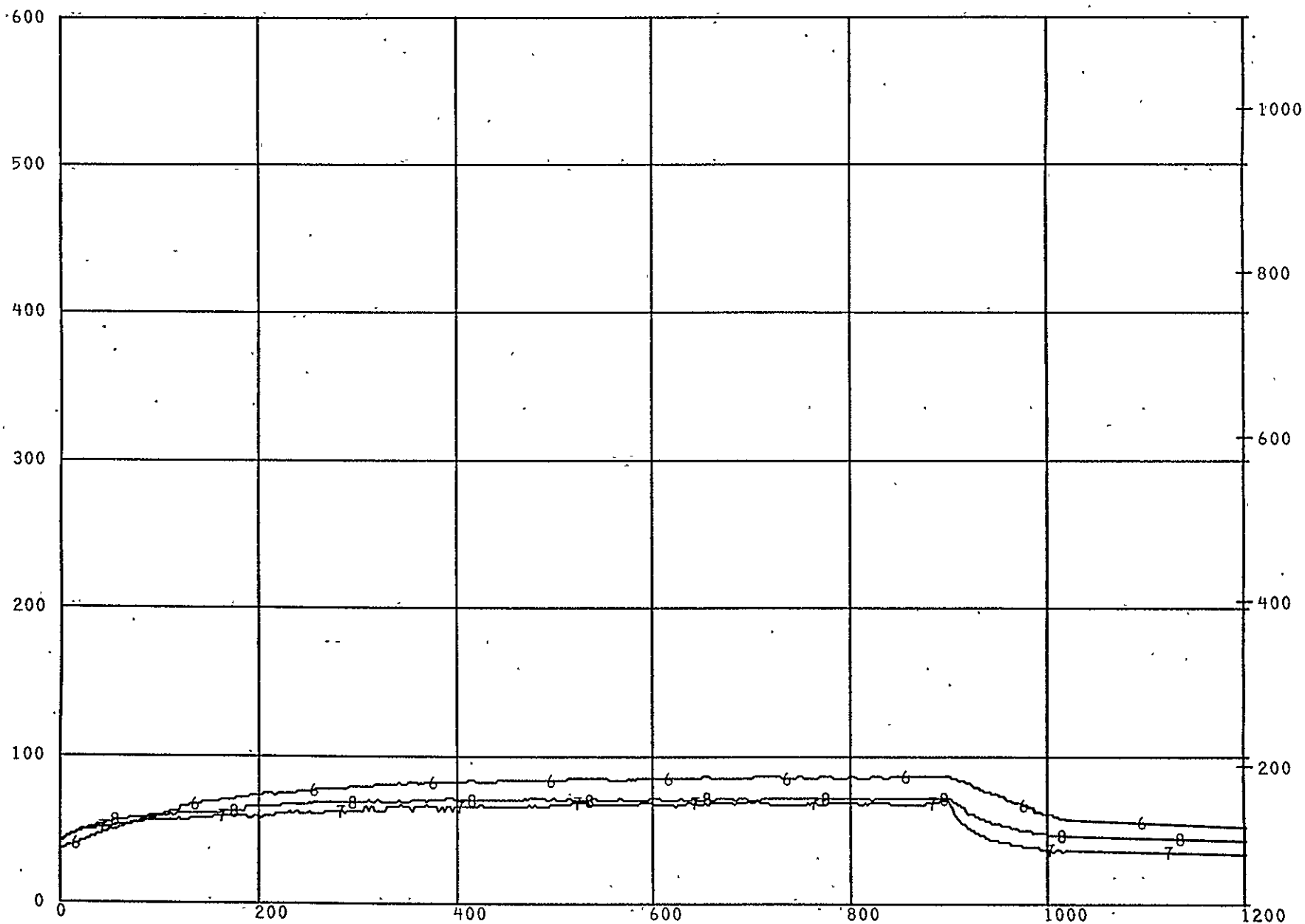
MEAS. NUMBER	CHANNEL ASGN.
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

316



MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8

TEST ID 840288 095000

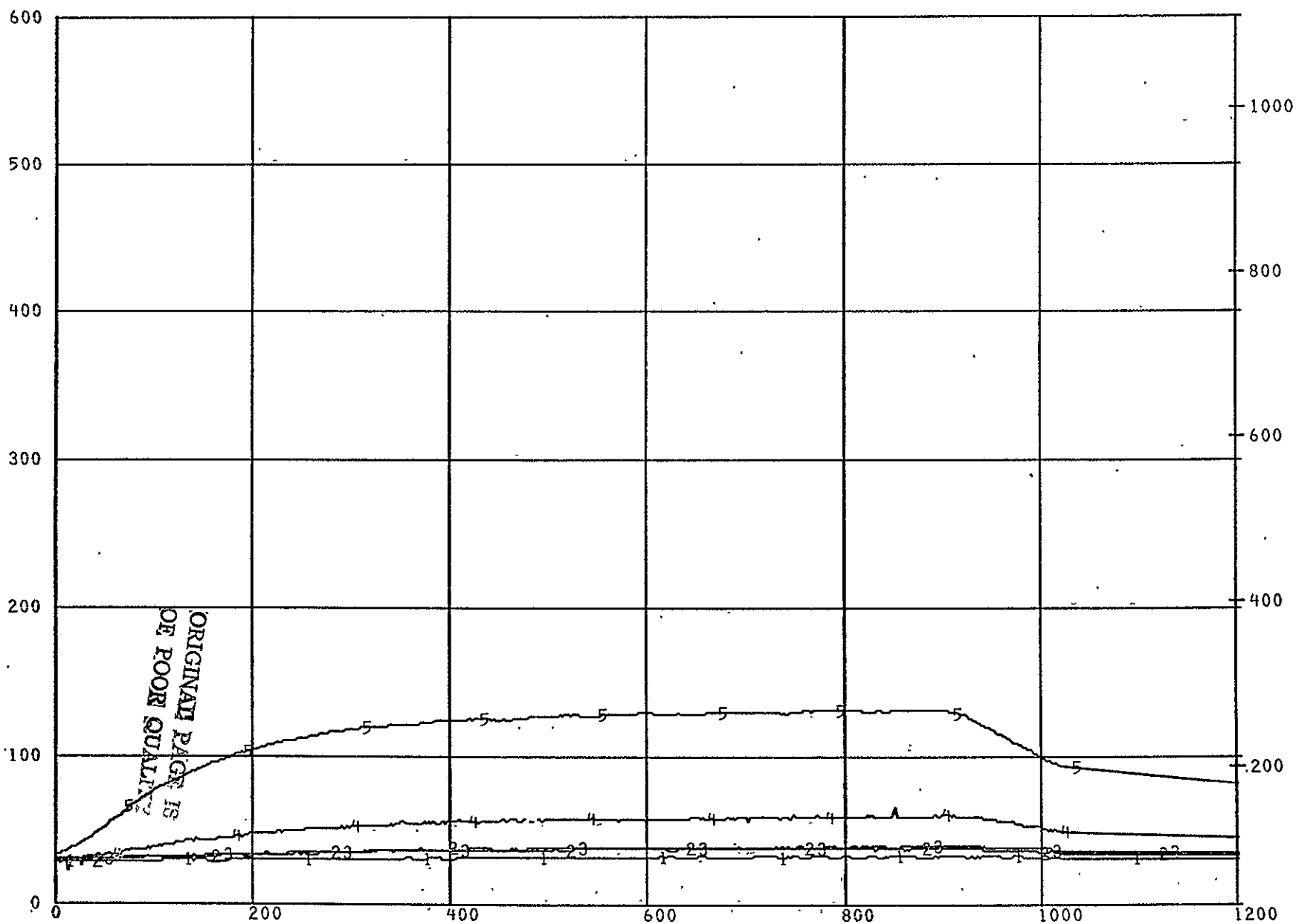
ST28B

PLOT NO

5 - 1

REFERENCE TIME 13 22 56.000

317



MEAS. NUMBER	CHANNEL ASGN.
\$ TC14	134
\$ TC15	135
\$ TC16	136
\$ TC17	137
\$ TC18	138

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

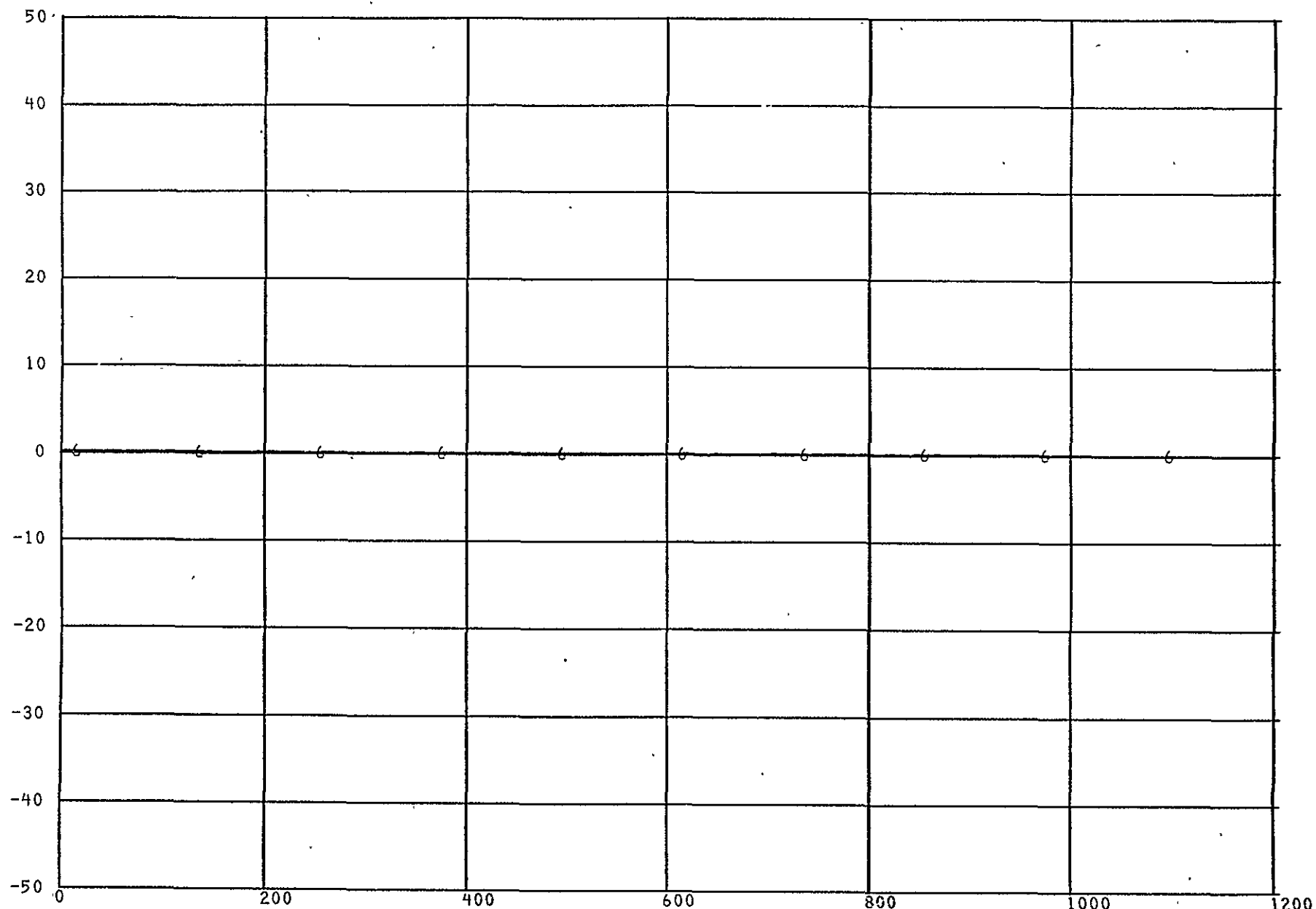
UNITS	GRID-SYM
DEG C	A1
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

TEST ID 840288 095000

ST28B

PLOT NO 6 - 1

REFERENCE TIME 13 22 56.000



318

MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

RELATIVE TIME IN SEC
TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
IN-H20 A6

TEST ID 840288 095000

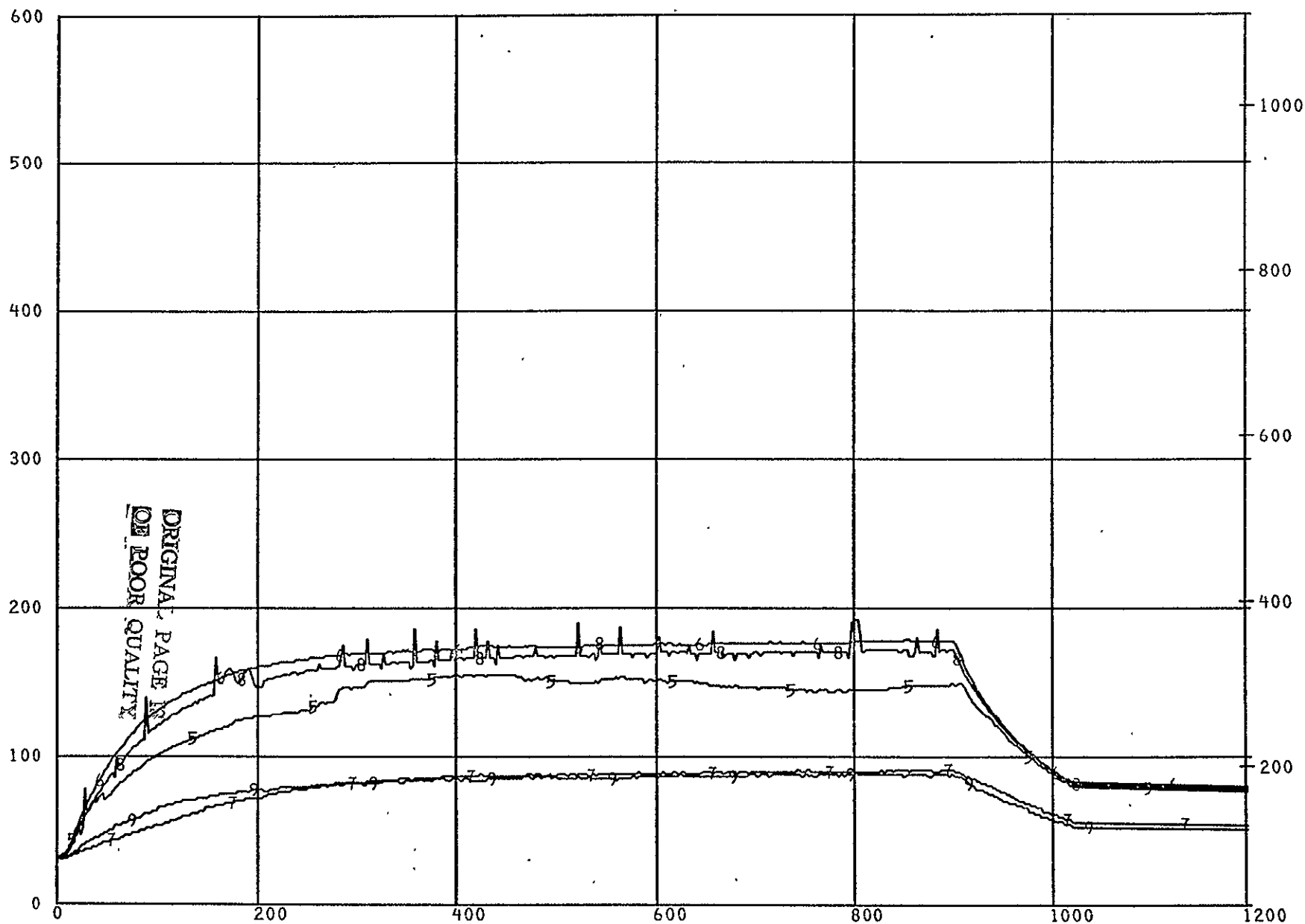
ST28C

PLOT NO

2 - 1

REFERENCE TIME 13 56 37.000

319



MEAS. NUMBER	CHANNEL ASGN.
\$ TC05	105
\$ TC06	106
\$ TC07	107
\$ TC12	132
\$ TC13	133

RELATIVE TIME IN SEC
TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A5
DEG C	A6
DEG C	A7
DEG C	A8
DEG C	A9

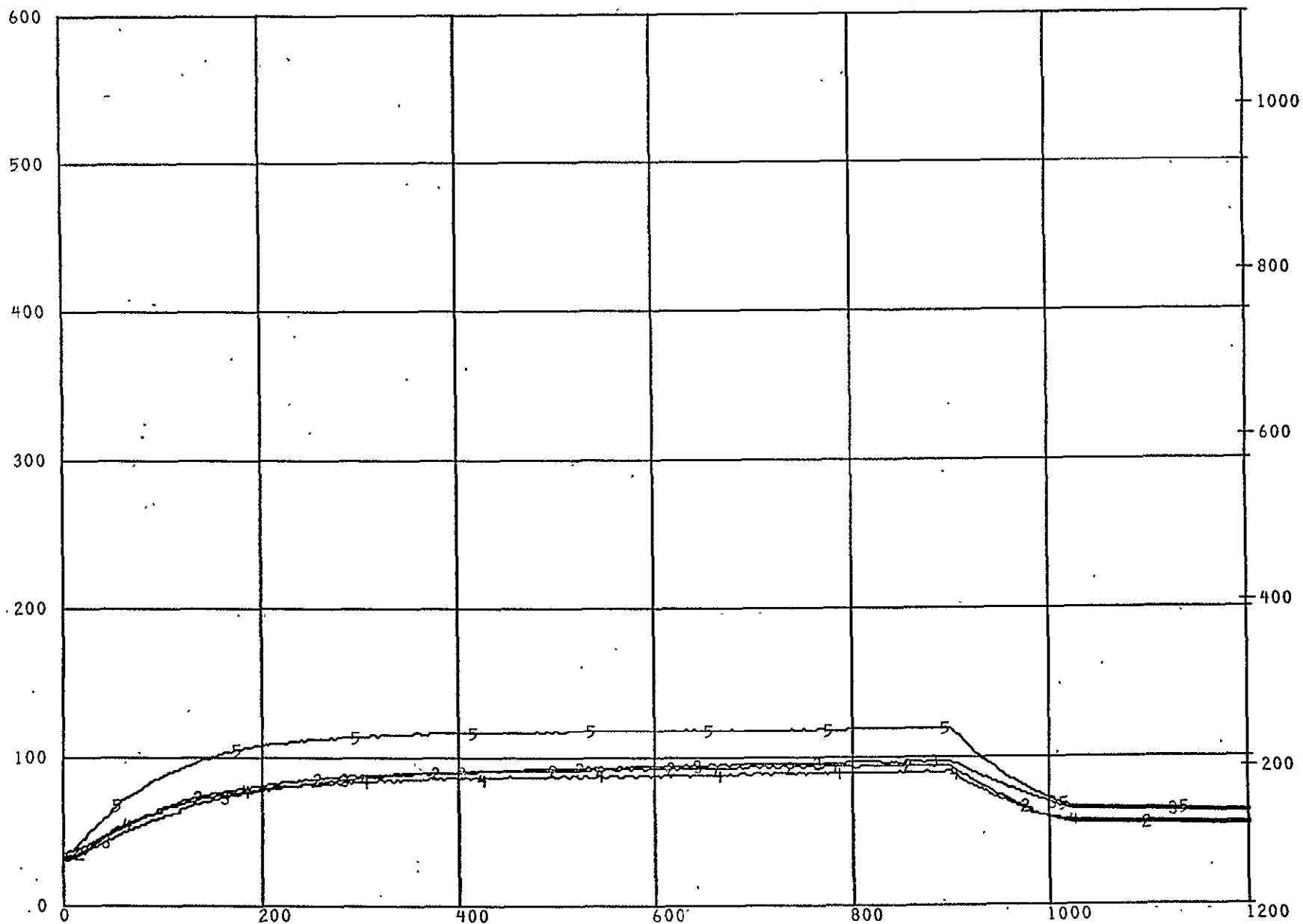
TEST ID 840288 095000

ST28C

PLOT NO 3-1

REFERENCE TIME 13 56 37.000

320



MEAS. NUMBER	CHANNEL ASGN.
\$ TC02	102
\$ TC03	103
\$ TC09	109
\$ TC08	108

TITLE

RANGE
0 TO 600
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A2
DEG C	A3
DEG C	A4
DEG C	A5

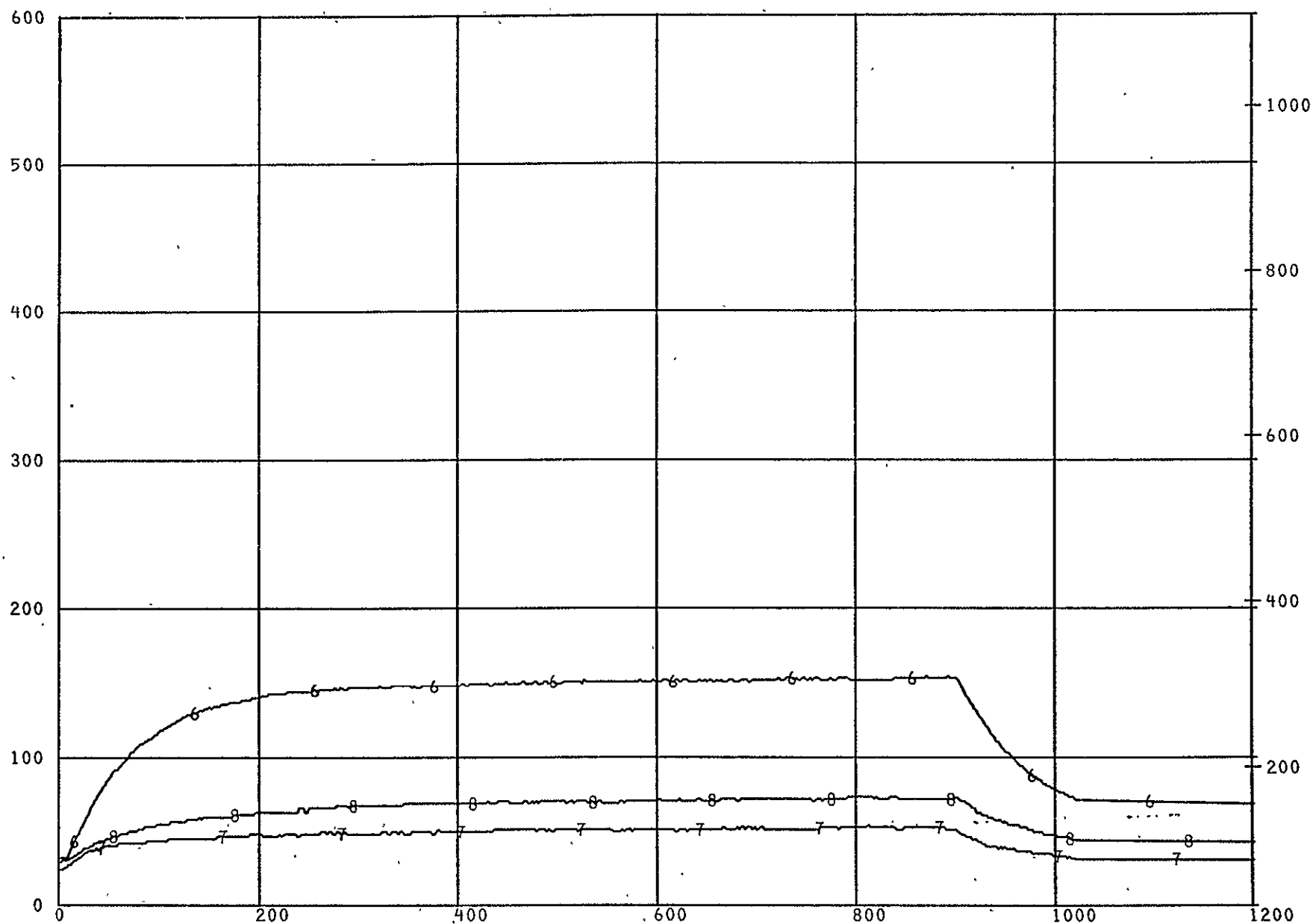
TEST ID 840288 095000

ST28C

PLOT NO 4 - 1

REFERENCE TIME 13 56 37.000.

321

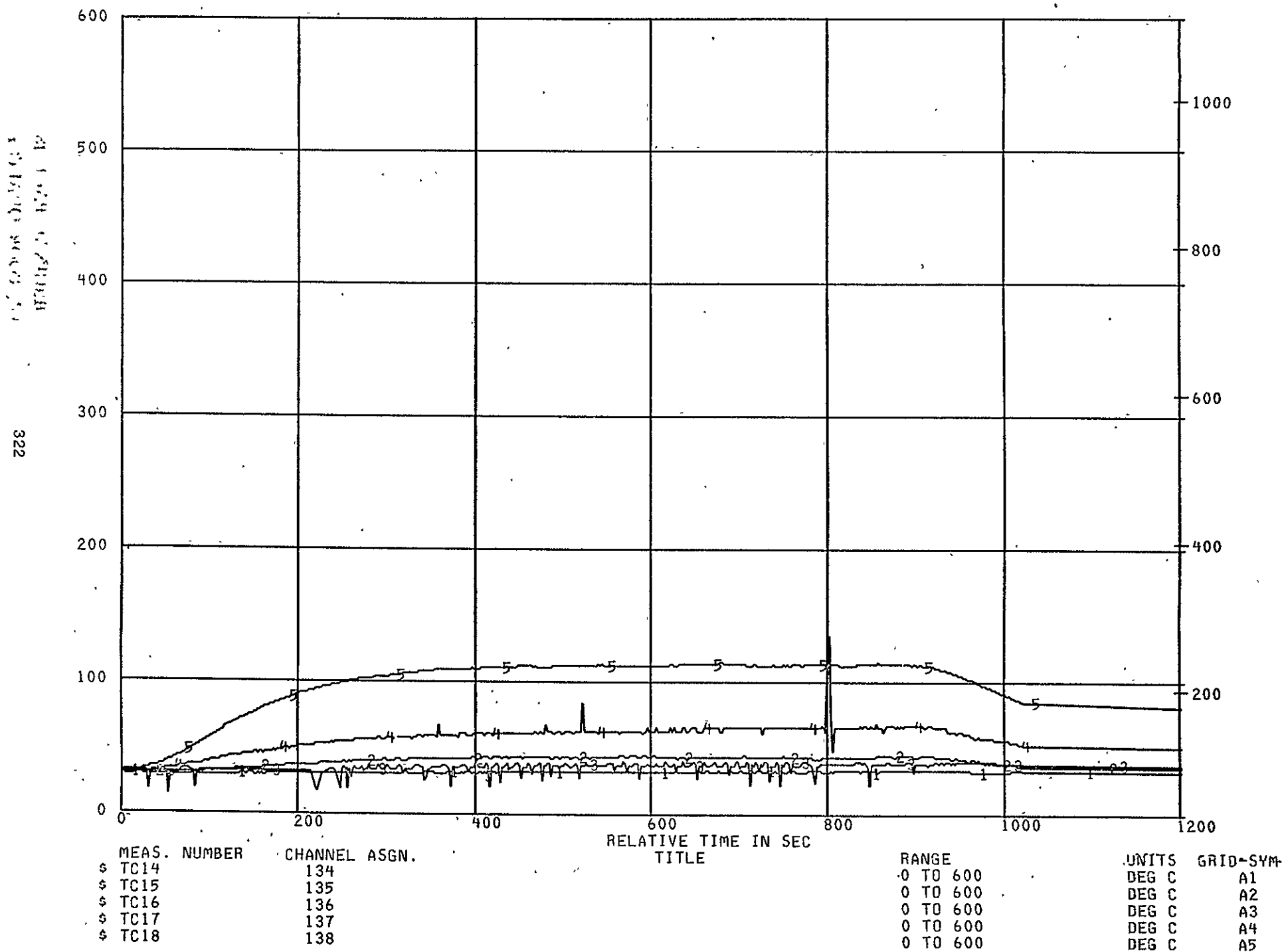
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OF POOR QUALITY

MEAS. NUMBER	CHANNEL ASGN.
\$ TC04	104
\$ TC10	130
\$ TC11	131

TITLE
RELATIVE TIME IN_SEC ...

RANGE
0 TO 600
0 TO 600
0 TO 600

UNITS	GRID-SYM
DEG C	A6
DEG C	A7
DEG C	A8



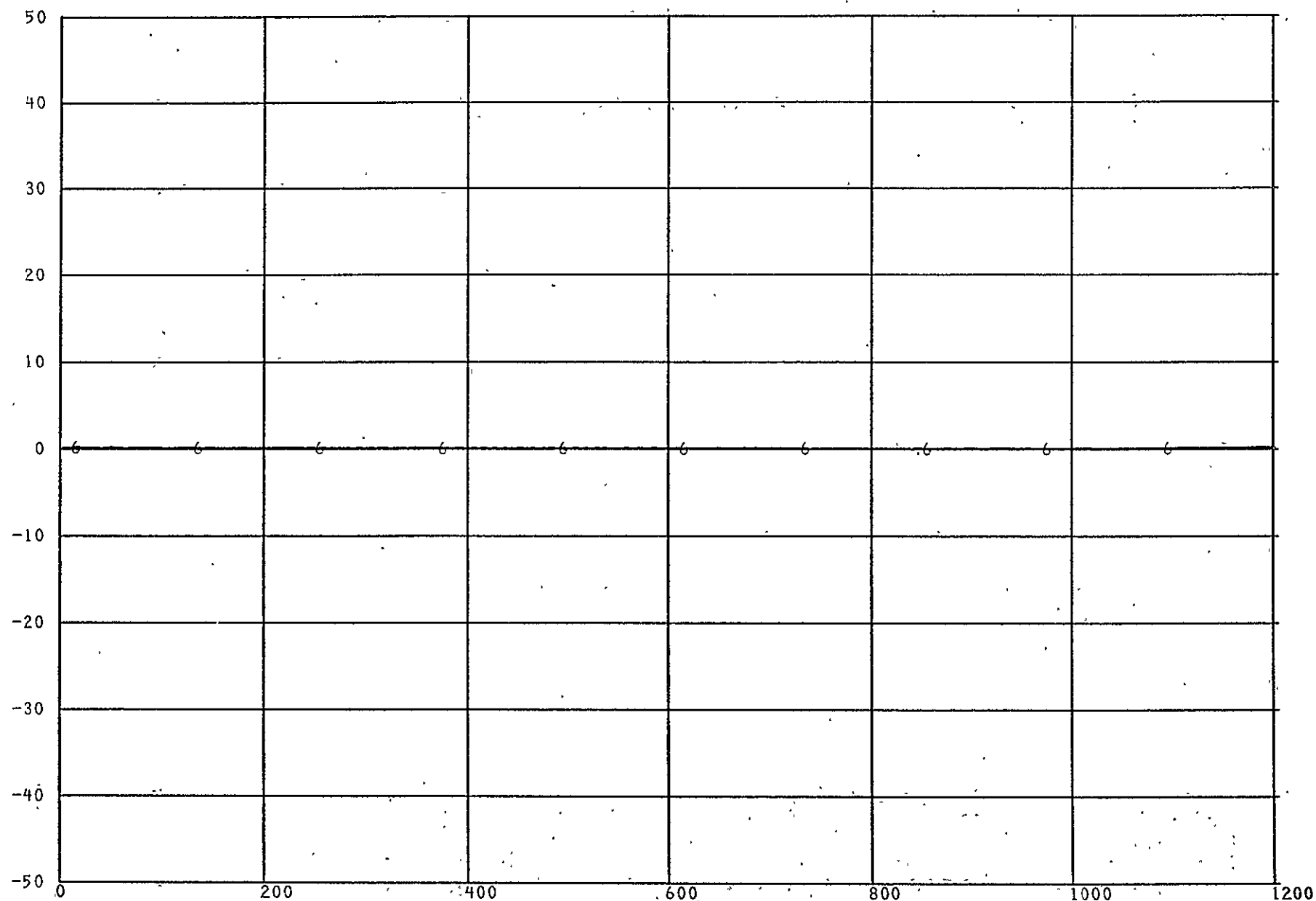
TEST ID 840288 095000

ST28C

PLOT NO

6-1

REFERENCE TIME 13 56 37.000



MEAS. NUMBER
PRESS

CHANNEL ASGN.
098

RELATIVE TIME IN SEC
TITLE
CABIN DELTA PRESSURE

RANGE
0.0 TO 20.0

UNITS GRID-SYM
1N-H20 A6

APPENDIX IV MATERIAL TEST PROCEDURES

Adhesive Tests

The five candidate contact adhesives were tested for relative toxicity and flash fire propensity. The test data from these tests and data from other screening tests provided the basis for selection of the best adhesive to use for construction of the multiple layer seat cushion test specimens tested by heat release calorimetry.

Relative Toxicity Tests

The candidate contact adhesive samples were allowed to cure for several days prior to testing. Swiss-Webster strain male albino mice weighing approximately 25 grams were exposed to pyrolysis/combustion products generated within a 5.3 liter volume rectangular glass chamber sealed at the top with a plexiglas lid. An exercise wheel and drive mechanism, electrical power leads for the microcombustion tube used for pyrolysis/combustion of the sample, and a radiation shield were mounted on the lid.

With the subject placed inside the exercise wheel, and a 0.1-3 gram adhesive sample loaded into the microcombustion tube (connected to power leads), aluminum foil radiation shield in place, assembly integral with the lid was inserted in the chamber and clamped in sealed position. A magnetically driven fan stirrer was placed in the chamber to provide rapid mixing of the pyrolysis/combustion products evolved from the test specimen during a run.

Final preparation for conducting a test consisted of connecting a variable speed electric motor to drive the exercise wheel and the Variac transformer controlled power leads to the pyrolysis/combustion tube feed-through leads on the lid.

The test parameters used in these tests were:

Exercise wheel rotation speed - 6 RPM

Input power - 20 VAC, 5.3 amperes

Sample heating rate - 300°C/minute

Heating period - 200 seconds

Biological endpoints - Time to incapacitation, Ti
Time to death, Td

Total test time (per run) - 30 minutes

Each animal was acclimated to the rotating wheel for a 2-minute period before initiation of the sample heating phase of the test. Temperature measurements during a run showed increases very rarely exceeding 40°C (104°F), usually the atmosphere within the chamber peaked near 30°C (86°F) which will not alone result in a Ti or Td endpoint for mice. Oxygen levels in the chamber do not deplete below 15%. The biological endpoints were timed by visual observation. Td was arbitrarily recorded as the elapsed time for cessation of breathing.

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The relative toxicity results are summarized in Table IV, Section 3.3. While the data showed considerable scatter, the results indicated that the R-2332 N/F adhesive, with aging to reduce solvent retention was a good candidate. RTV-133 also showed relatively lower toxicity since an endpoint was not achieved until 1.5g samples were tested.

Flash Fire Propensity Tests

The NBS Flash Fire Cell was modified in design and fabricated to NBS and DAC specifications. It was constructed of heavy wall pyrex glass, duplicating as closely as possible the size and configuration described in Reference 5.

The cell was modified, by incorporation of a miniature, electrically powered, pyrolysis tube furnace in a demountable side arm of the apparatus. It was anticipated that this feature would permit faster and more reproducible heating regimes than provided by the NBS external heater design. See Reference 5.

Further important modifications have been incorporated. A thermocouple junction was inserted through the septum at H₂, with the junction positioned in the center of the main vertical tube. This TC and the TC probe inserted in the sample within the pyrolysis tube were connected respectively in series to a dual channel recorder. During a test, the output from the sample pyrolysis zone TC and the main tube TC were recorded simultaneously on the same chart. The latter TC automatically detected a flash fire front traveling vertically upward as the test proceeded.

A cycle control and timer with counter connected to the 10 KV transformer spark generator was set to cycle the 1 cm spark in the base of the cell for approximately 0.5 sec with a repetition rate of 6 per minute. The heat generated in the air inside the main tube was detected on the recorded TC trace as a short upscale pulse each time the ignition source spark was cycled. Power for the pyrolysis combustion tube heating coil was supplied by a Variac transformer (20 amp) and adjusted manually to preselected wattage level. This pyrolysis assembly permitted the selection of virtually any heating profile (max. approx. 600°C/min.) by adjustment of the voltage level. The coil wire was found to be uniform in output; theoretical heating levels (thermal flux) from 0.1 to 4 watt cm² (over internal surface of the pyrolysis tube) were attained.

Test Procedure -

The candidate adhesive materials were tested using the following selected pyrolysis heating regime and operational procedures.

- (a) A 0.5 g sample, weighed to ± 0.0001 g was inserted in a preweighed heating coil/pyrolysis tube assembly.
- (b) The pyrolysis tube with the sample was installed in the side tube and connected to the Variac power source.
- (c) The pyrolysis zone TC probe was inserted through the entrance tube in cap/joint D and plugged into the ice point electronic reference. The recorder range for this output was set on 50 mv/FS.
- (d) The flash fire detector TC was inserted through port H₂; connected to the ice point electronic reference and the recorder range set to 5 mv/FS.
- (e) The cycle time was set for a 0.5 sec. spark at 10 sec. intervals and the counter set to zero.
- (f) The dual pen recorder was started at a paper transport speed of 6.25mm per minute.
- (g) Each experimental run was initiated by switching on the pyrolysis coil power, the spark cycle time and depressing the hand-held record event marker switch to mark time zero on the recorder chart. Power to the pyrolysis tube was smoothly and rapidly (5 sec.) adjusted to 5.5 amp (at 19.1 volt).
- (h) The outlet at the internal end of the pyrolysis tube was observed and the event marker switch was depressed to mark the recorder chart at the time of first appearance of smoke.
- (i) Visual appearance, estimated quantity and color of smoke, and relative intensity (light, sound, flame front travel) or violence of a flash reaction was noted.
- (j) When a flash occurred, additional air was allowed to enter momentarily into the bottom of the cell by depressing the spring loaded flow-off cap. Multiple flashes were detected and visually assessed for intensity.
- (k) Experimental runs continued for 5 minutes (30 spark source cycles) at which time power was shut off and the experiment terminated.
- (l) After cooling, the pyrolysis tube and sample were weighed to obtain the char residue.
- (m) The flash fire cell was disassembled and cleaned preparatory to the next test.

Thermogravimetric Analysis

The candidate materials were tested for weight loss by standard procedures using a DuPont Instrument Company Thermal Analyzer. Approximately 5 to 15 mg samples were introduced into the sample cup and heated at a rate of 20°C per minute in a low flow of dry air (75 ml/min). Rates of weight loss versus temperature (time) were recorded by potentiometric recorder until no further weight loss was detected (usually in 30 to 35 minutes).

Heat and Smoke Release Rate and Thermal Penetration Tests

The candidate multilayer seat cushion specimens, Appendix I, Figure 6, were tested in the Ohio State University version of the heat release rate calorimeter (HRR), Reference 8. This calorimeter was used to evaluate the heat and smoke released from 25 X 25 cm multilayer specimens laid up in the sample holder as shown in Figure IV-1, when exposed to a radiant flux of 3.5 w/cm². Quantitative measures of heat released in terms of kilowatt (kw) or BTU/minute were calculated per square meter (m²) of original surface areas exposed as a function of time.

The Douglas (modified) HRR chamber and auxiliary pen recorder and gas monitoring instrumentation is employed to evaluate the fire response of nonmetallic materials. The principal value of testing the seat materials in the HRR calorimeter was to provide an insight into the dynamic response of each material in a fire environment, and the potential contribution of each material in the cushion to the propagation of fire. These characteristics are applicable to the identification and selection of the best materials for seat construction in each use category as discussed in the report.

A special modified, lightweight, stainless steel sample holder and refractory backing board of low thermal capacitance was used for all tests to reduce heat absorption by the holder immediately following injection of the mounted sample into the HRR chamber. As indicated in Figure IV-1 up to 3 chromel alumel thermocouples were included in the multilayer test specimens to measure the thermal penetration rates of heat into the layup at three locations (two on baseline specimens). The locations of these TC's shown for each specimen are shown in Appendix I, Figure 6.

Figure IV-2 lists the physical characteristics of the samples and the HRR calorimeter operational modes and parameter settings.

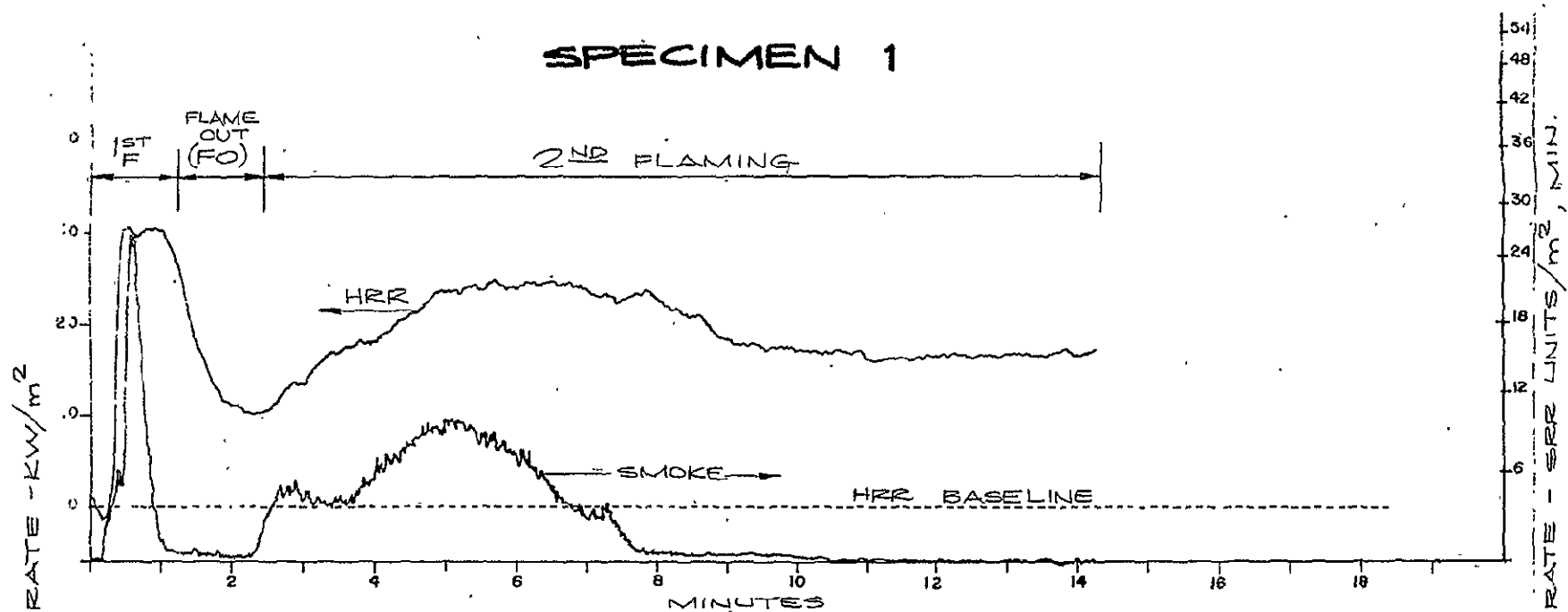
For screening purposes of the program the samples were not conditioned per the method outlined in Reference 9. Samples were stored in a laboratory atmosphere varying from 38-45% relative humidity.

The electrically powered Glowbar^R radiant panel heating source was adjusted to the required thermal flux using a Hycal Radiometer-Calorimeter and allowed to equilibrate to a constant level with air flowing through the chamber. In most tests baseline recorded temperature variations (noise) differentially recorded between the air input temperature and the exit stack of the HRR were observed to hold within ± 0.5 division of chart (equivalent to approximately 1 Kw/m² heat release).

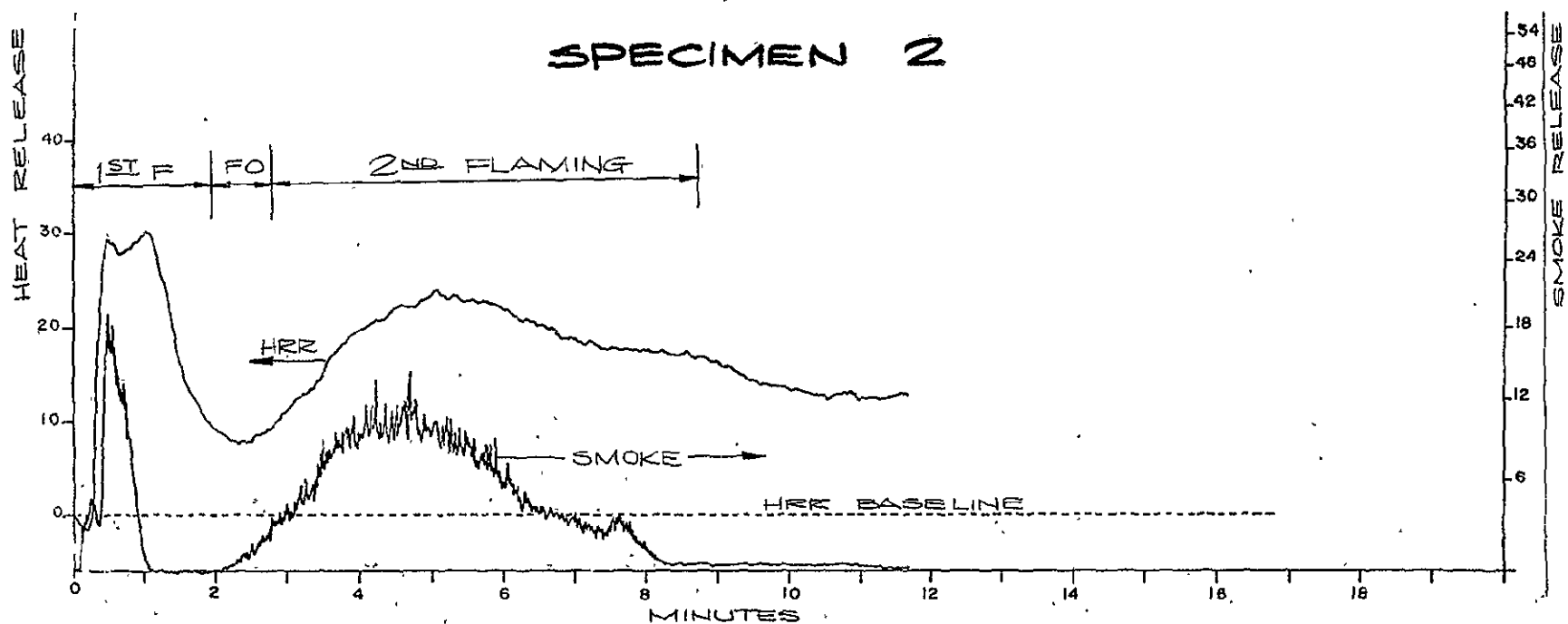
The recorded curves of heat (temperature) were read out and calculated against calibrations obtained at the same airflow setting as the test materials using natural gas of known heat content.

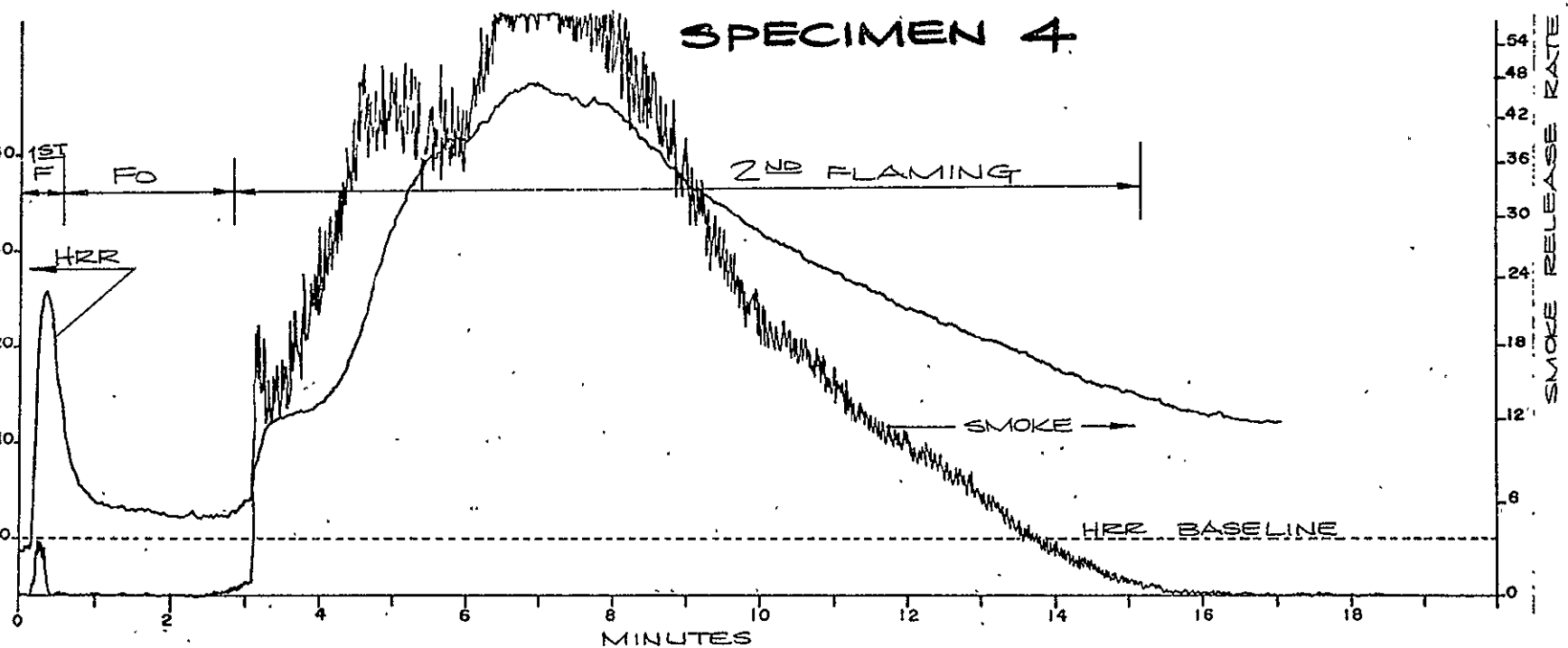
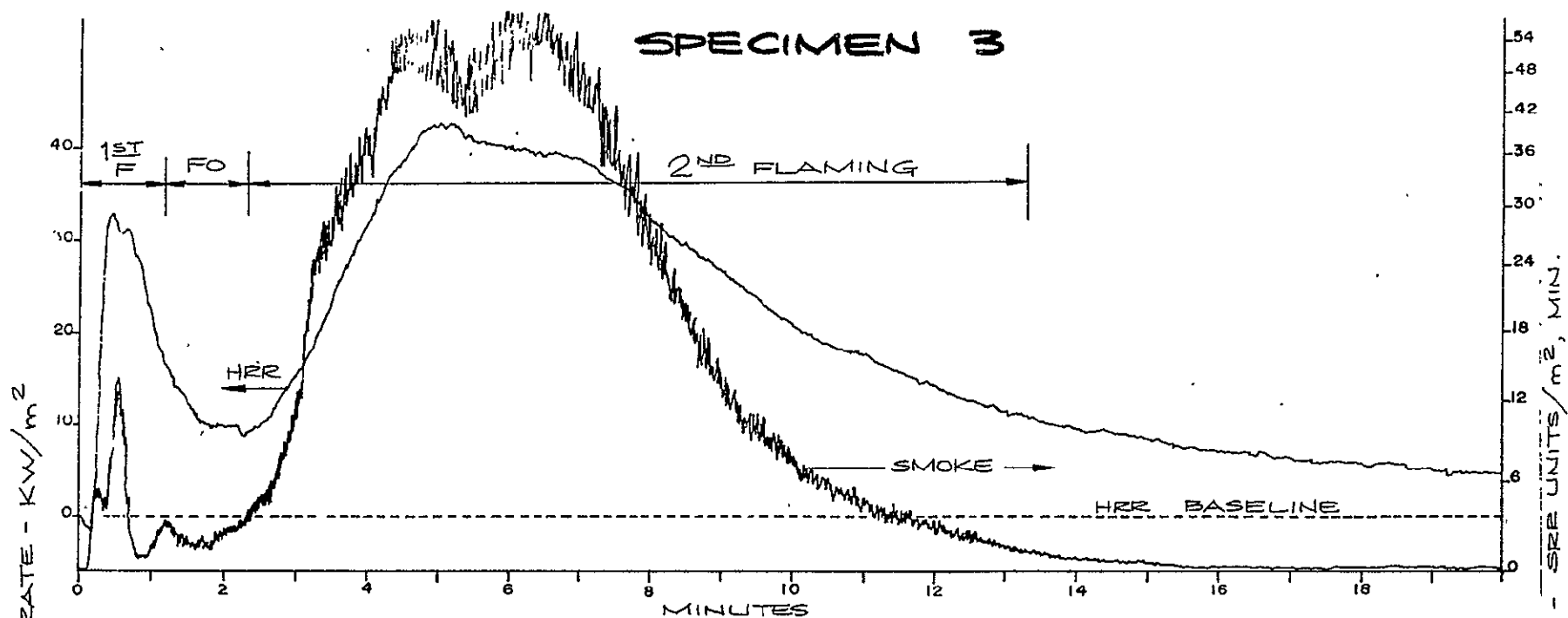
The heat and smoke release rate curves for Specimens 1 through 21 were traced from the original recorded data and are as follows:

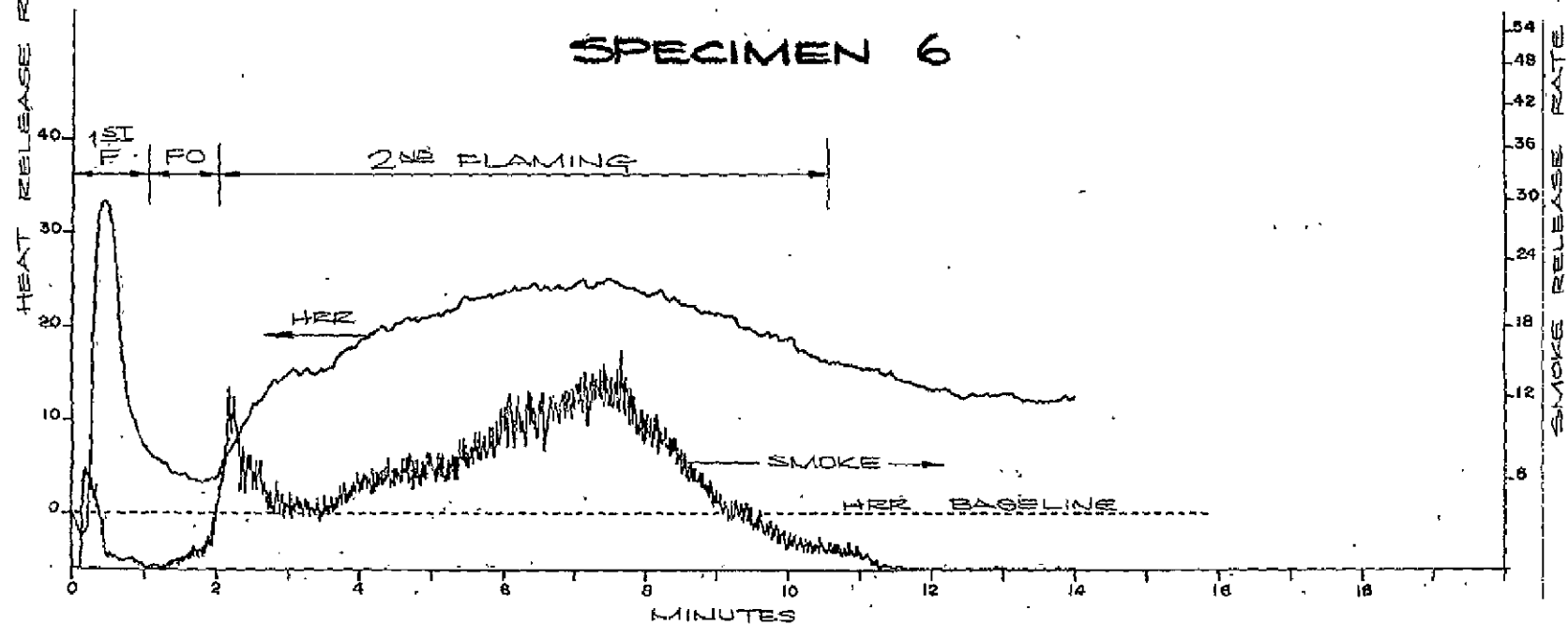
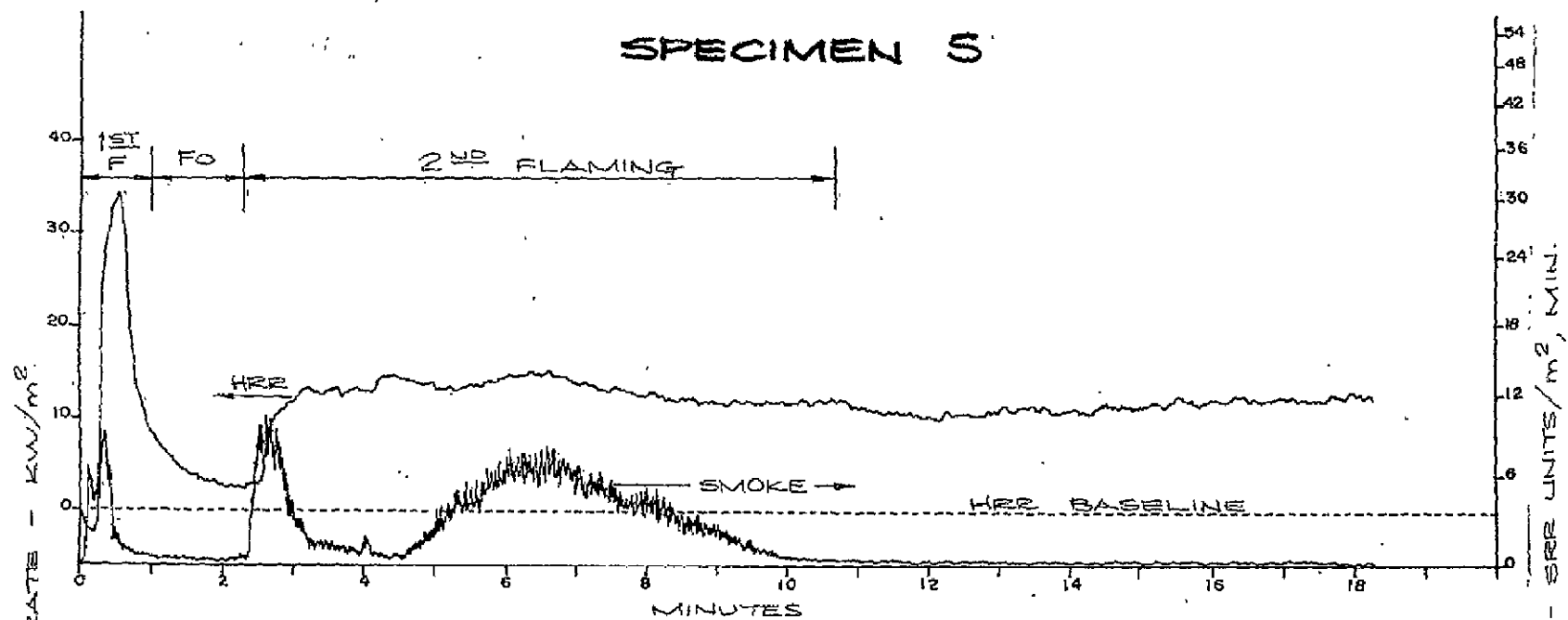
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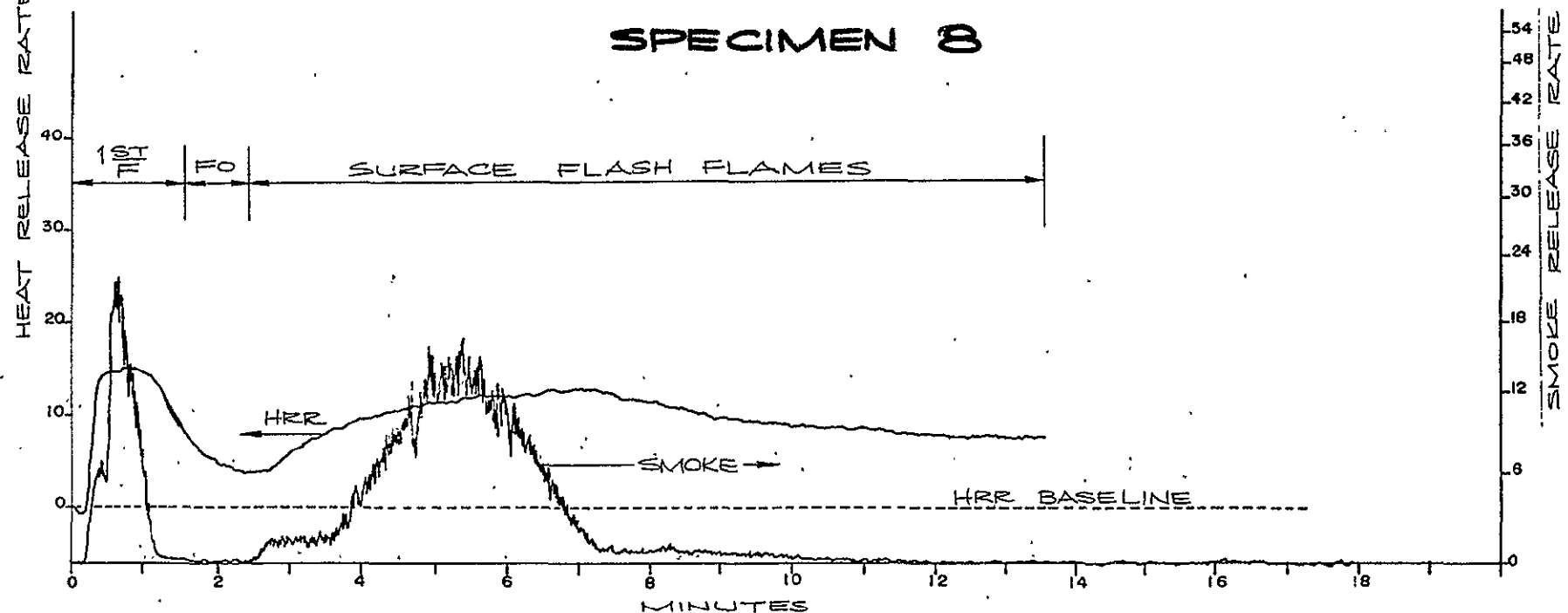
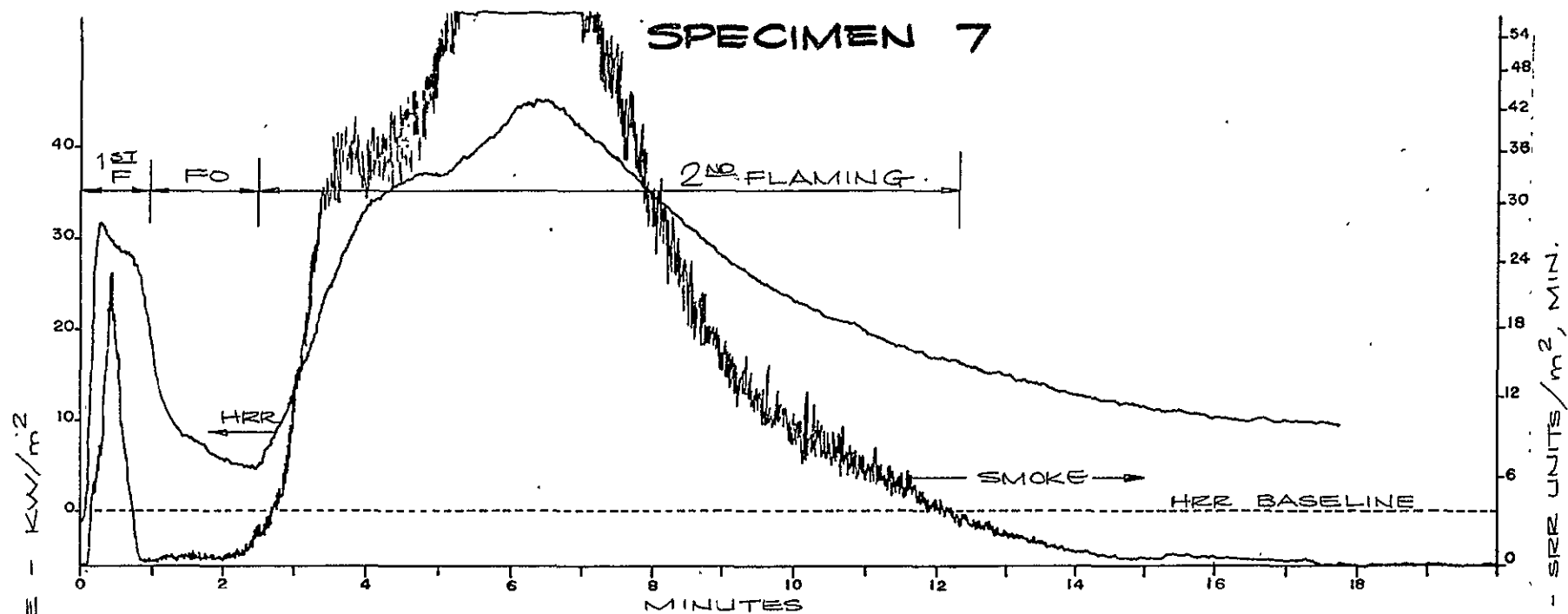


SPECIMEN 2

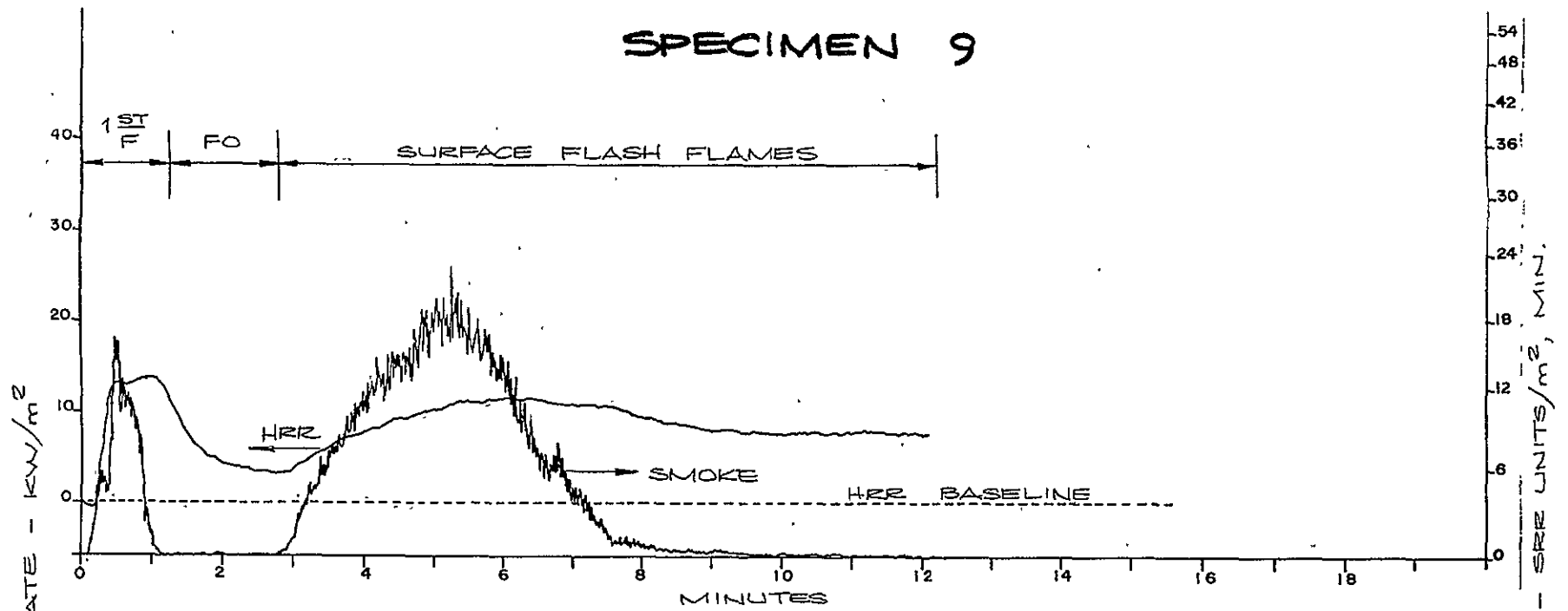




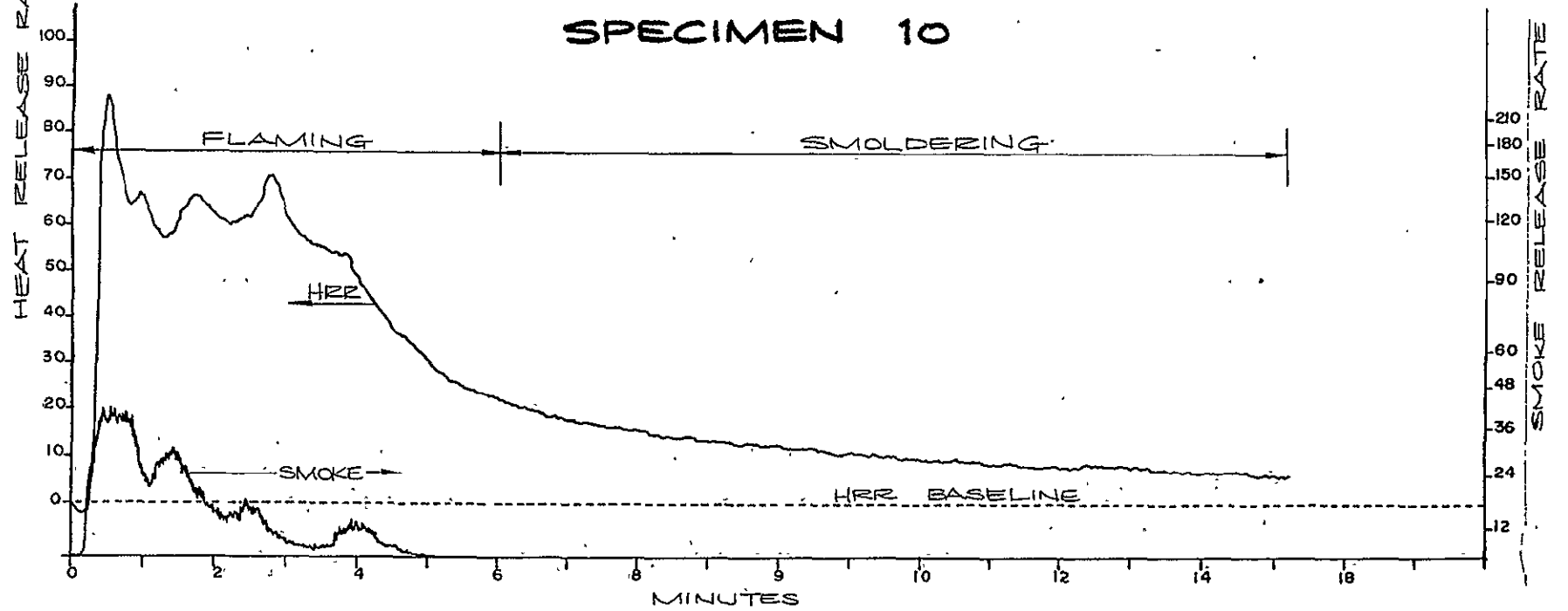


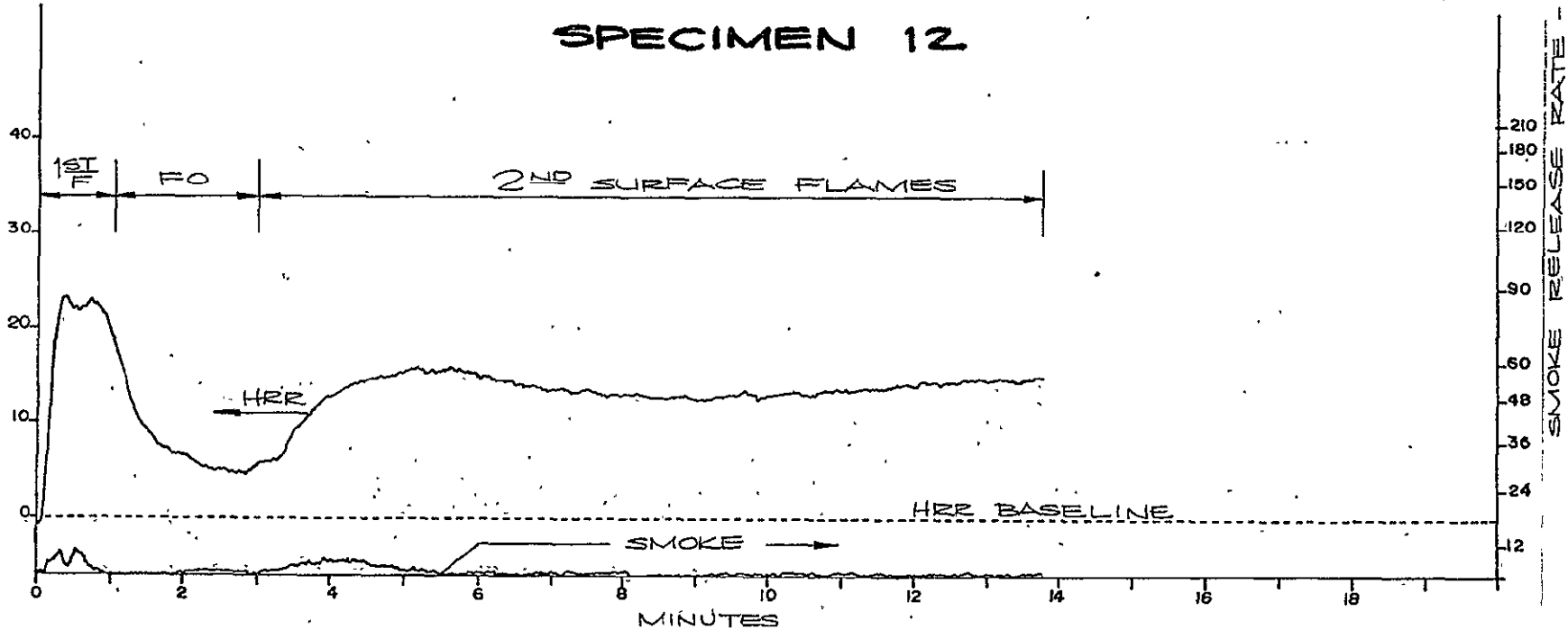
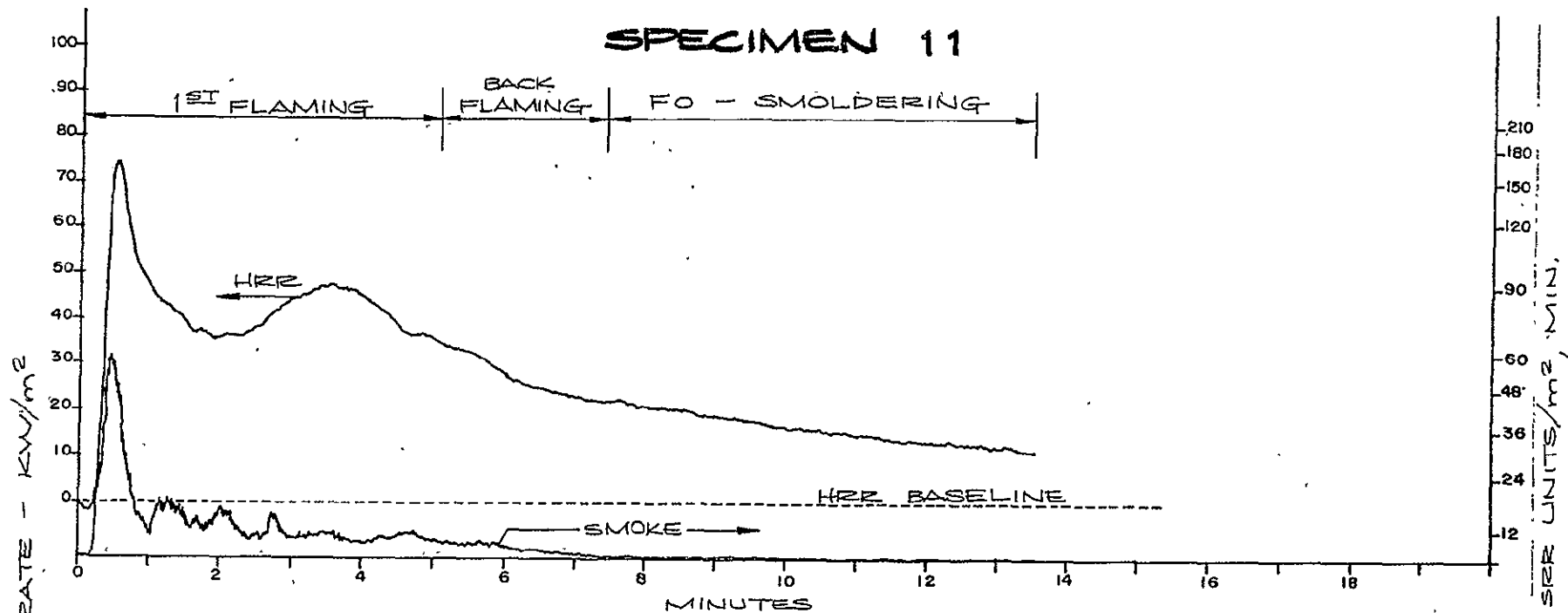


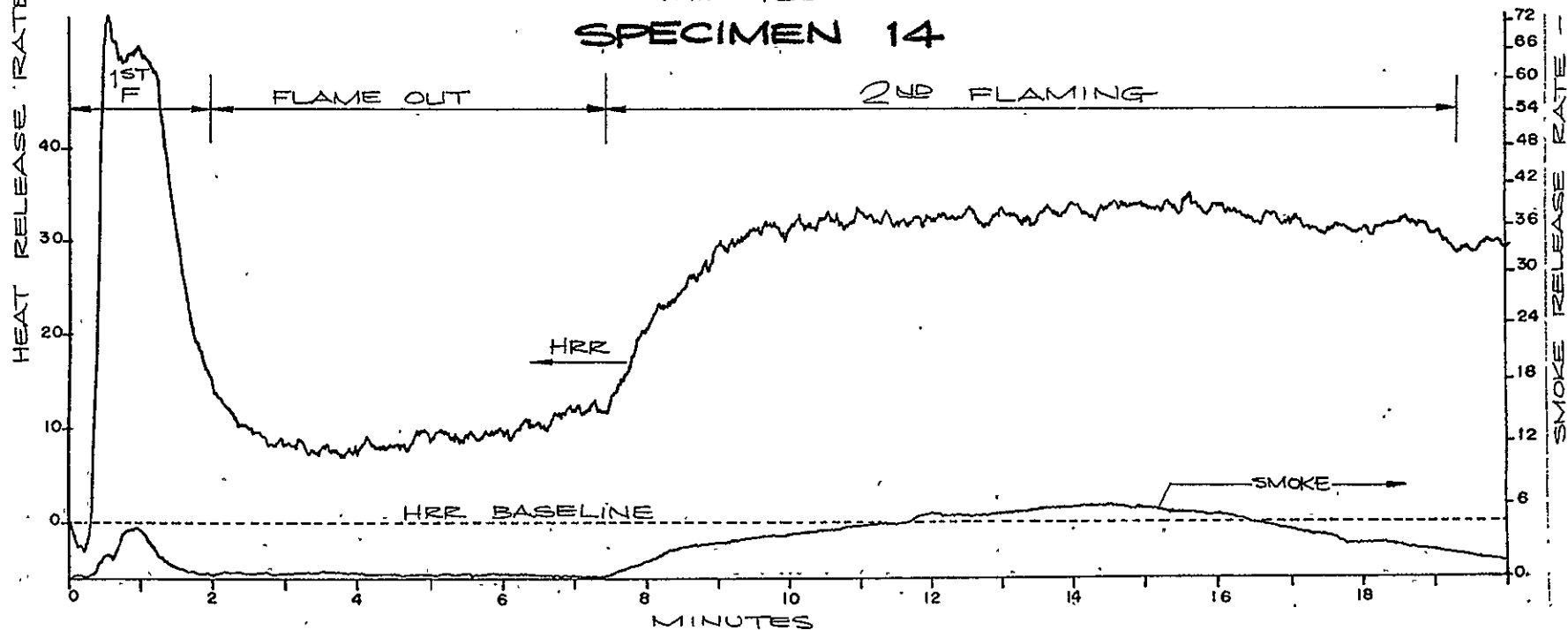
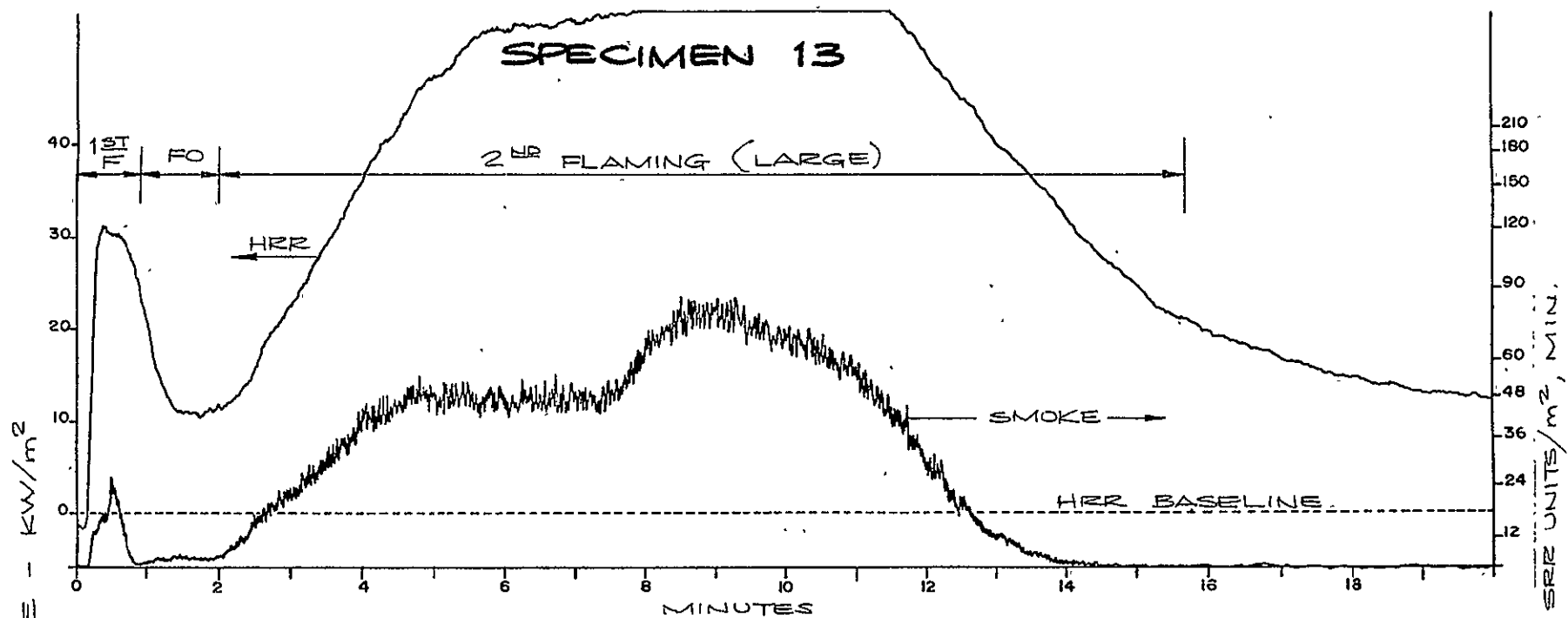
SPECIMEN 9



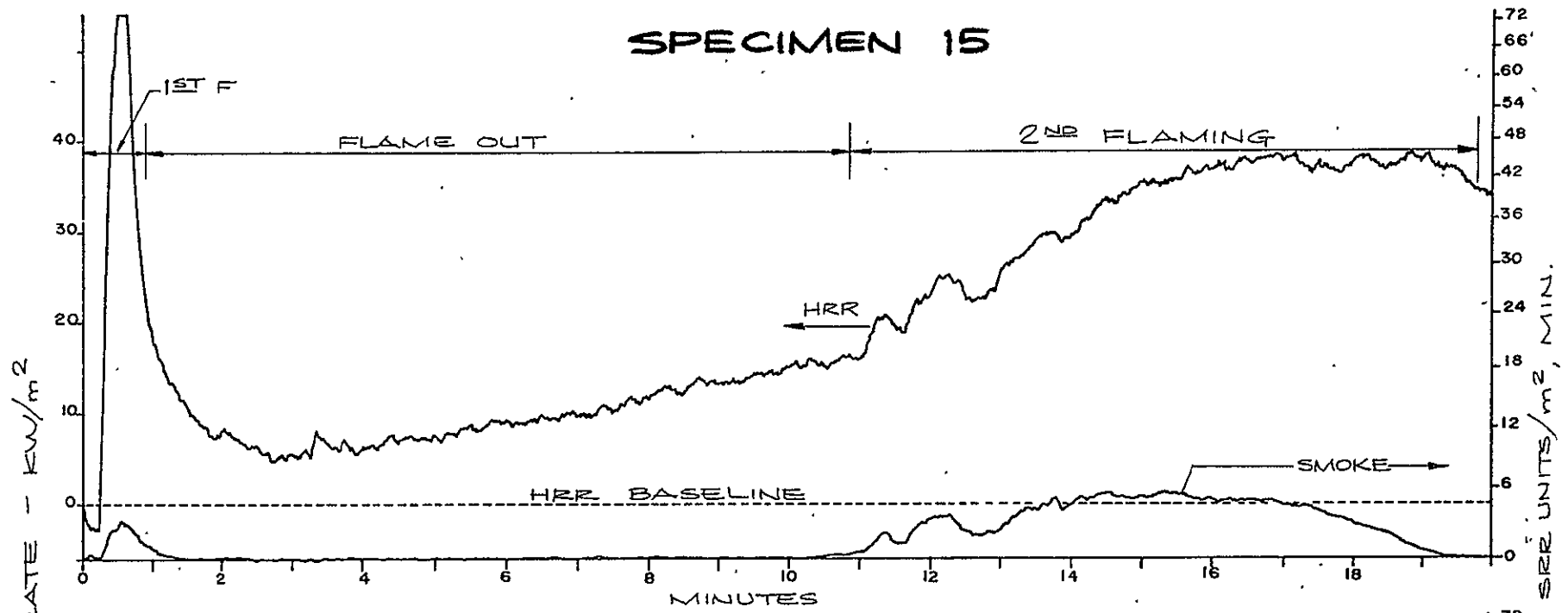
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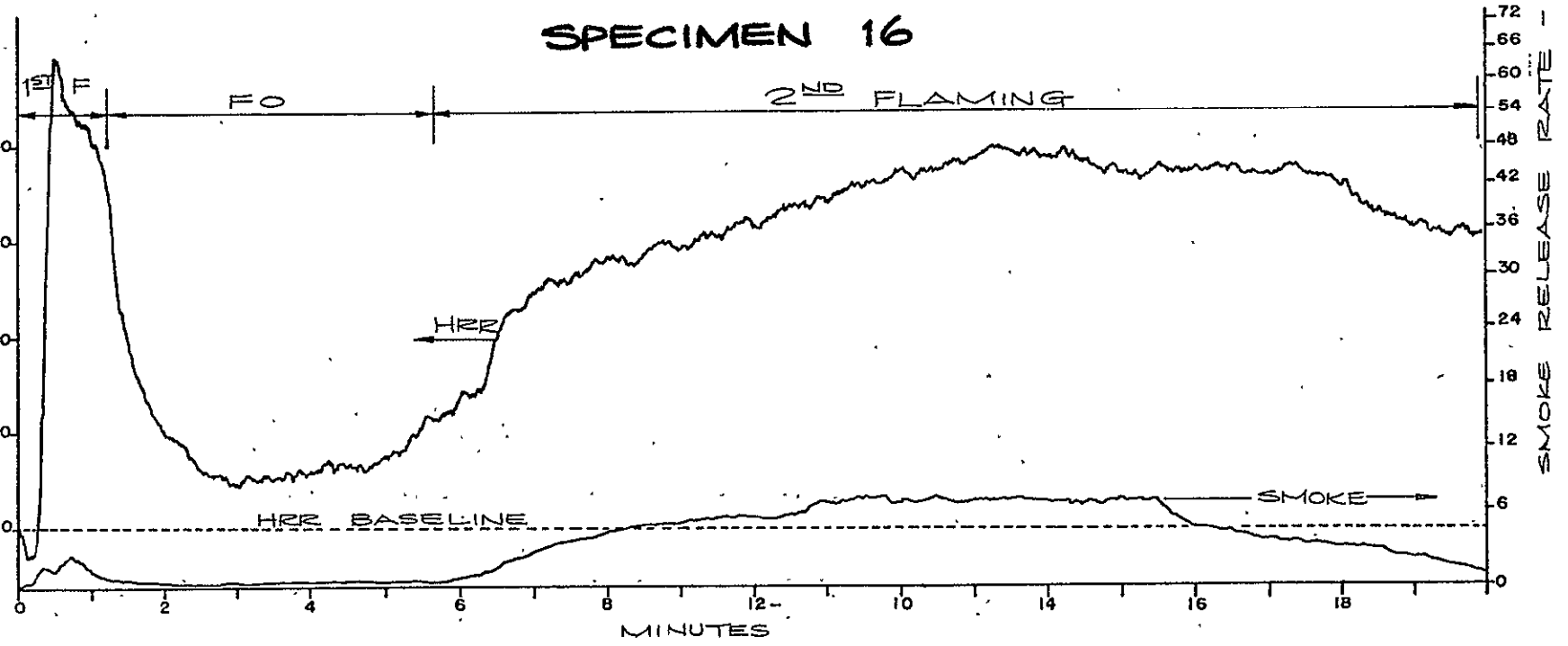




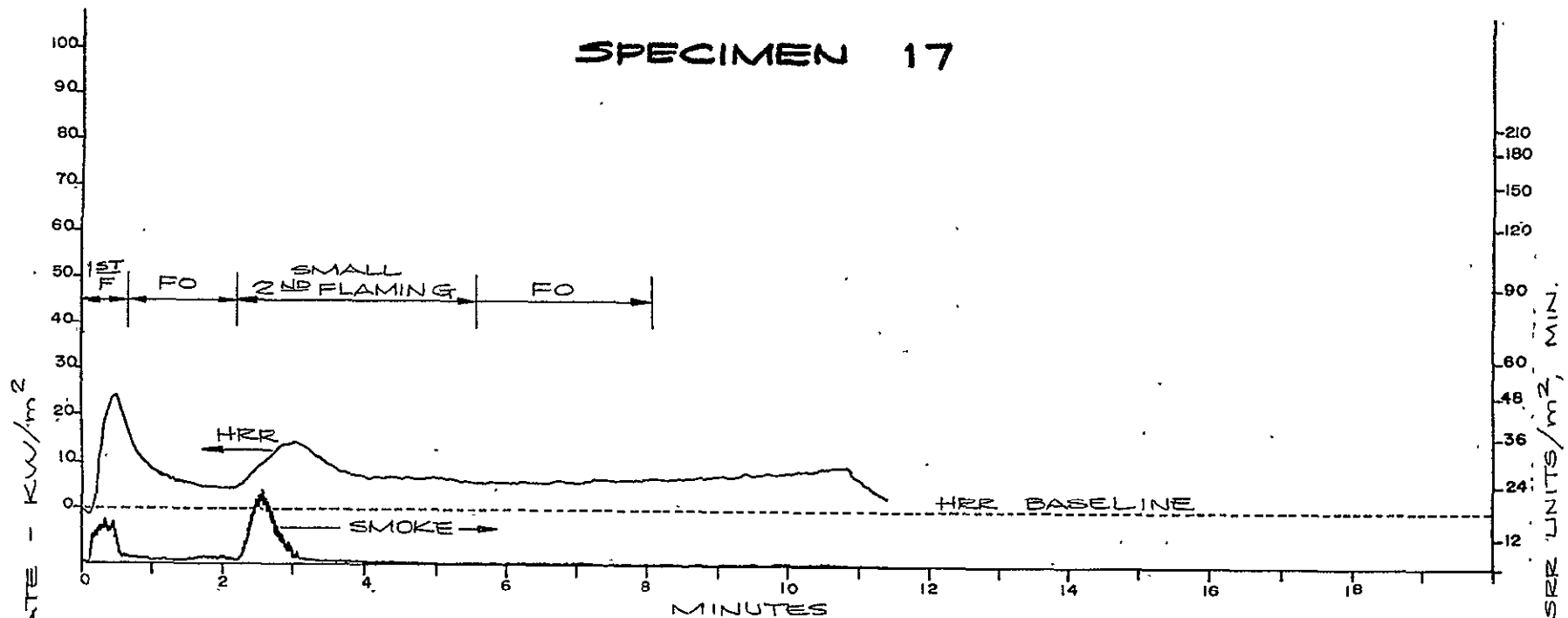
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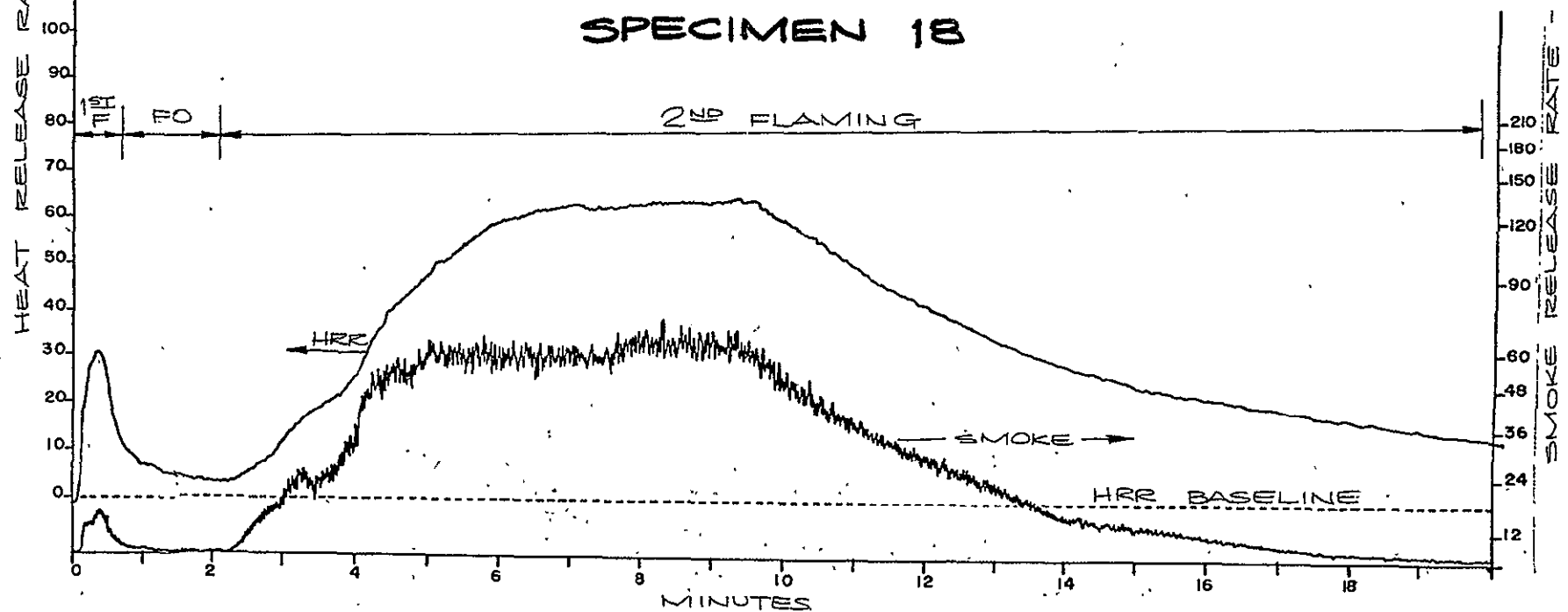
SPECIMEN 16

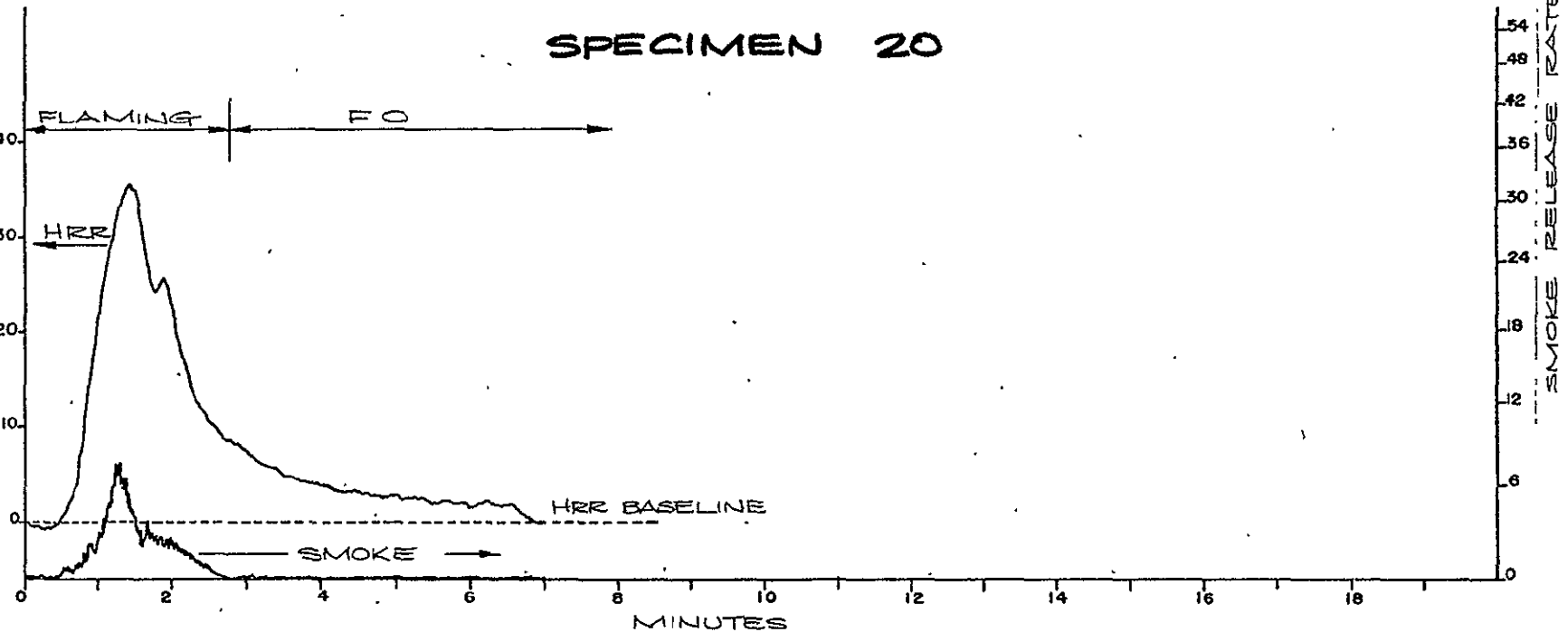
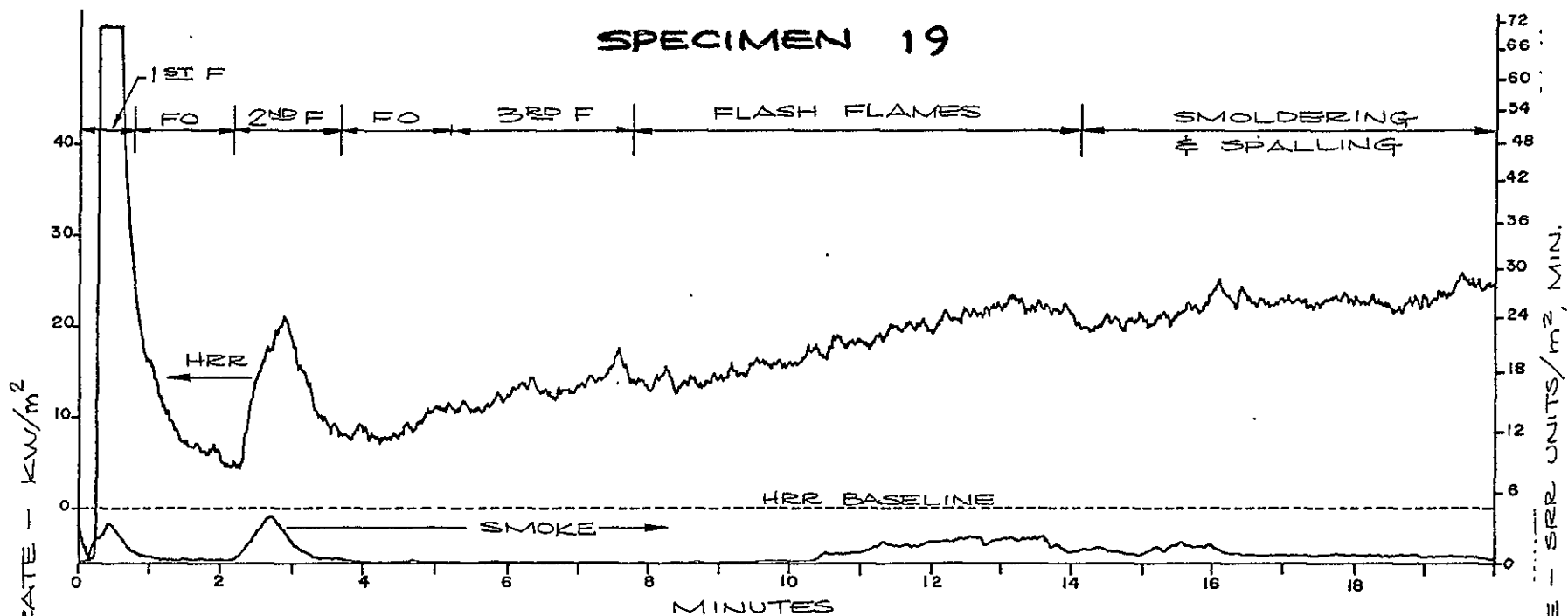


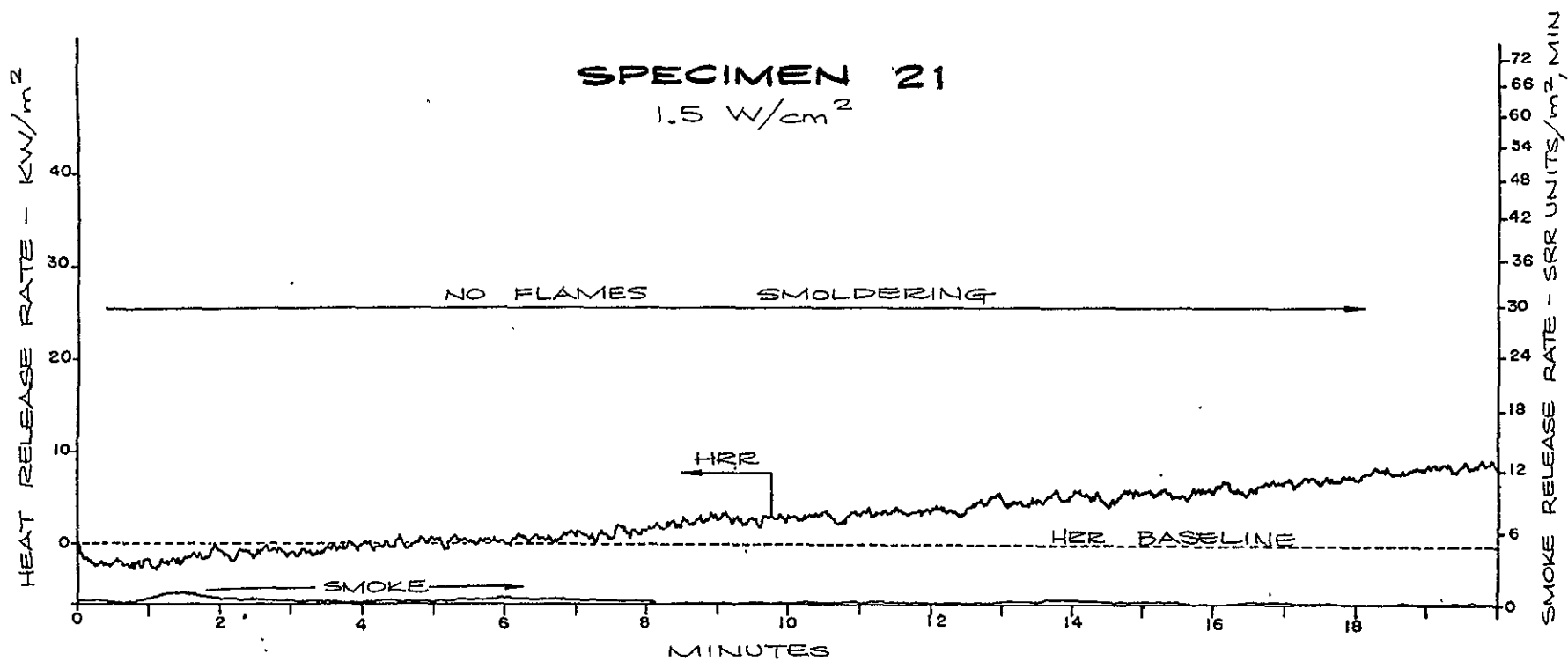
SPECIMEN 17



SPECIMEN 18







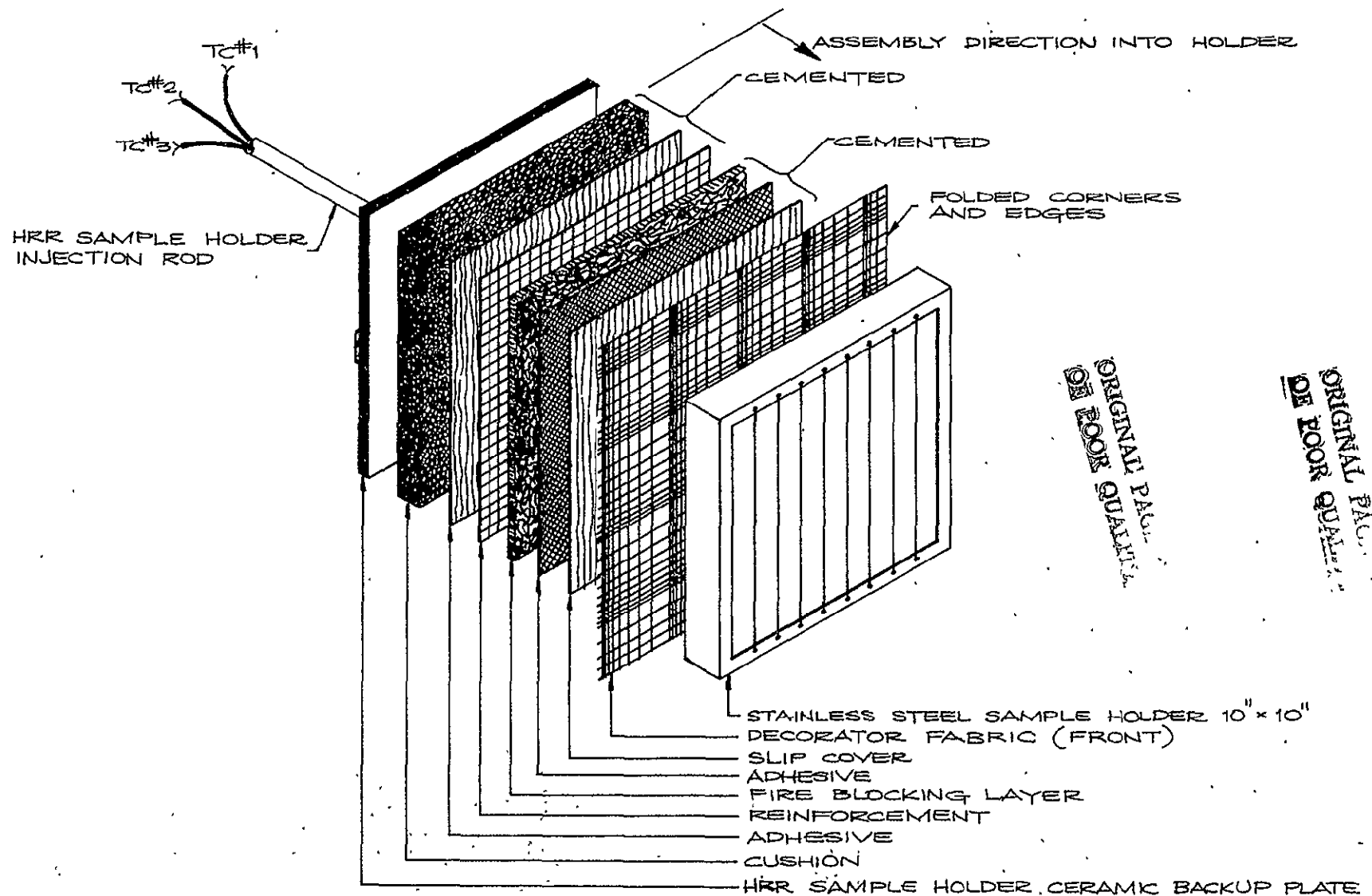


FIGURE IV-1. TYPICAL MULTIPLE LAYER TEST SPECIMEN

ITEM	PARAMETER	DATA UNITS
SAMPLE		
Identification	Material No. & Name	
Size	Length X Width X Thickness	25 x 25 cm (10 x 10 inch)
Thermal Exposure	Area	thickness mm (inch) 625 cm ² (100 in ²)
Orientation	Vertical	
HRR CALORIMETER		
Airflow (set)	Cubic Feet/Minute	60
Thermal Flux (set)	Watt/Centimeter ² (w/cm ²)	3.5
Test Time (set)	Sample Exposure Time	10 - 20 minutes
Visual Ignition	Time to Ignition	Seconds
Visual Flaming	Flame Travel Rate (FTR)	mm/sec
Ignition Test Mode	Point Pilot Flame\$	10 cm from Sample, bottom center and 10 cm above top edge, center
Heat Release	Max Heat Release Rate/Area Heat Release vs. Time/Area	KW/m ² at ____ sec KW/m ² , 1.5, 3, 5, 10 minute
Effective Heat of Combustion	Total Heat/Area (Integrated)	KW/m ² at ____ min
Smoke Release	Max. Smoke Release Rate/Area Smoke Release vs. Time/Area	SRR; 1 unit = 10% T Reduction/ meter Path SRR 3/m ² , 1.5, 3, 5, 10 min.
Total Smoke	SRR X Time (Integrated)	SRR/m ² at ____ min.

FIGURE IV-2. MULTILAYER CUSHION AND HRR CALORIMETER OPERATIONAL DATA

APPENDIX V

PRELIMINARY
NASA FIRE-HARDENED PASSENGER SEAT
SPECIFICATION

ORIGINAL PAGE IS
OF POOR QUALITY

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1.0 INTRODUCTION

1.1 Scope

This specification is for use by seat manufacturers who furnish passenger seat assemblies to the buyer.

1.2 Applicability

This specification delineates all buyer requirements for passenger seat assemblies and related equipment as determined by the NASA improved passenger seat program.

1.3 Compliance

The manufacturer shall comply with all requirements of this specification.

1.4 Deviation

Deviations to the requirements of this specification will be determined by negotiation with the buyer. Approved deviations to the requirements of this specification will be specified on the applicable approval data seat and equipment drawings.

2.0 APPLICABLE DOCUMENTS

2.1 Precedence

In the event of conflict between the documents cited herein, or between any of the documents and this specification, the Buyer shall be requested to provide order of precedence or resolution, prior to start of seat manufacturing.

2.2 Extent of Applicability

The following documents form a part of this specification to the extent specified herein. Unless otherwise noted, the issue in effect at the date of Purchase Agreement shall apply.

2.2.1 Standards

2.2.1.1 Federal

FED-STD-245

Tolerances for Aluminum
Alloy and Magnesium Alloy
Wrought Products

Federal Aviation Administration (FAA)

2.2.1.1 Federal (Continued)

Federal Aviation Regulations (FAR)

Part 25

Airworthiness Standards:
Transport Category
Airplanes

Smoke Generation Test Method, NBS

25.000
Appendix F(g)

Wire Burn Test - 60 Degrees

25.853 b3

Horizontal Burn Test, Four Inches/Minute

25.853 b

12 - Second Vertical Burn Test

25.625

Lap Belt Attach Fittings

25.1359

Electrical System Fire & Smoke Protection

Part 37

Technical Standard Orders (TSO)

37.3

TSO Authorization Required

37.132

Safety Belts - (TSO-C22)

37.136

Aircraft Seats and Berths (TSO-C39a)

37.178

Individual Flotation Devices (TSO C-72)

2.2.2 REPORTS

ASTM D2843-70

Measuring of Density of Smoke From
Burning or Decomposition of Plastics

3.0 REQUIREMENTS

3.1 Manufacturers Responsibility

The manufacturer is responsible for:

- a. Establishing a location and date for inspection and acceptance-testing of the seat assemblies as required in paragraph 4.1 and notifying the buyer at least two weeks in advance.
- b. Implementing any required corrective action on any seat assemblies rejected for failure to pass the qualification or acceptance tests.
Implementing any corrective action or repair, including shipment to the seat manufacturing facilities, if the seat assemblies do not pass the buyer's visual inspections for fit, form and function.

3.1 Manufacturers Responsibility (Continued)

- c. Proving that non-metallic materials (including finishes) shall meet the burn requirements of this specification and the applicable FAR's. In the event of conflict, this specification shall govern.
- d. Supplying a list of smoke density rating showing that all non-metallic materials have been selected having the lowest practical smoke density rating after 90 seconds and 4 minutes when tested per method_____.
- e. Performing tests and submitting test reports substantiating compliance with Paragraph 3.4.4 prior to delivery of seats to the buyer. The buyer shall be notified two weeks in advance of the tests and may elect to send representatives to witness the test.
- f. Furnishing seat assemblies with an emergency oxygen system compartment and associated wiring that functions as intended in aircraft service regardless of deficiencies or omissions of this specification and its referenced documents or success attained in laboratory tests.

3.2 Buyer's Responsibility

The buyer shall be responsible for:

- a. Designating, at its option, a representative to witness the acceptance test.
- b. Visually inspecting the seat assemblies for damage or deterioration that may have occurred during shipping. The inspection shall be at the buyer's facility and upon arrival of the seat assemblies.
- c. Notifying the manufacturer if the seats do not pass visual inspection.

3.3 General Design Requirements

3.3.1 Interface

3.3.1.1 Seat Assembly Attachment to Curved Tracks

The design of the leg assemblies for the passenger seat units shall accommodate the departure from the rectangular configuration to a rhomboid configuration by a 1/2-inch forward (or aft) displacement that is necessary for alignment with curved floor-mounted seat track (see Figure 1); this movement shall be capable of infinite adjustment within the design range.

3.3.1.2 Floor-Mounted Seat Tracks

Dimensions and tolerances for floor-mounted seat tracks are specified in Figure 2.

3.3.1.3 Seat Track Design Loads

Passenger seat assembly loads shall be transmitted and distributed so that the limitations of the floor-mounted seat tracks (Figure 2 and Table 1) will not be exceeded.

3.3.1.4 Acceleration

The passenger seat assembly components shall be designed to withstand accelerations as follows:

<u>Direction Applied</u>	<u>Magnitude of Force</u>
Forward	9.0g
Aft	1.5g
Down	7.0g
Up	4.0g
Side	3.0g

TABLE I. Maximum load values of aircraft seat tracks for typical seat installations.

	S (lbs)	R (lbs)
UTILITY TRACKS		
Lightweight	3600	4000
Heavy Duty	5500	6000
STANDARD TRACK		
Continuous Section	5500	6000
Splice	3600	4000

This table is intended for use as a design guide only. These loads are absolute maximums and the actual allowable load will be dependent upon the type of track-attach fitting selected.
(Ref. para 3.3.1.6)

NOTE: Rear seat-leg fitting must transfer vertical loads into track with two studs.

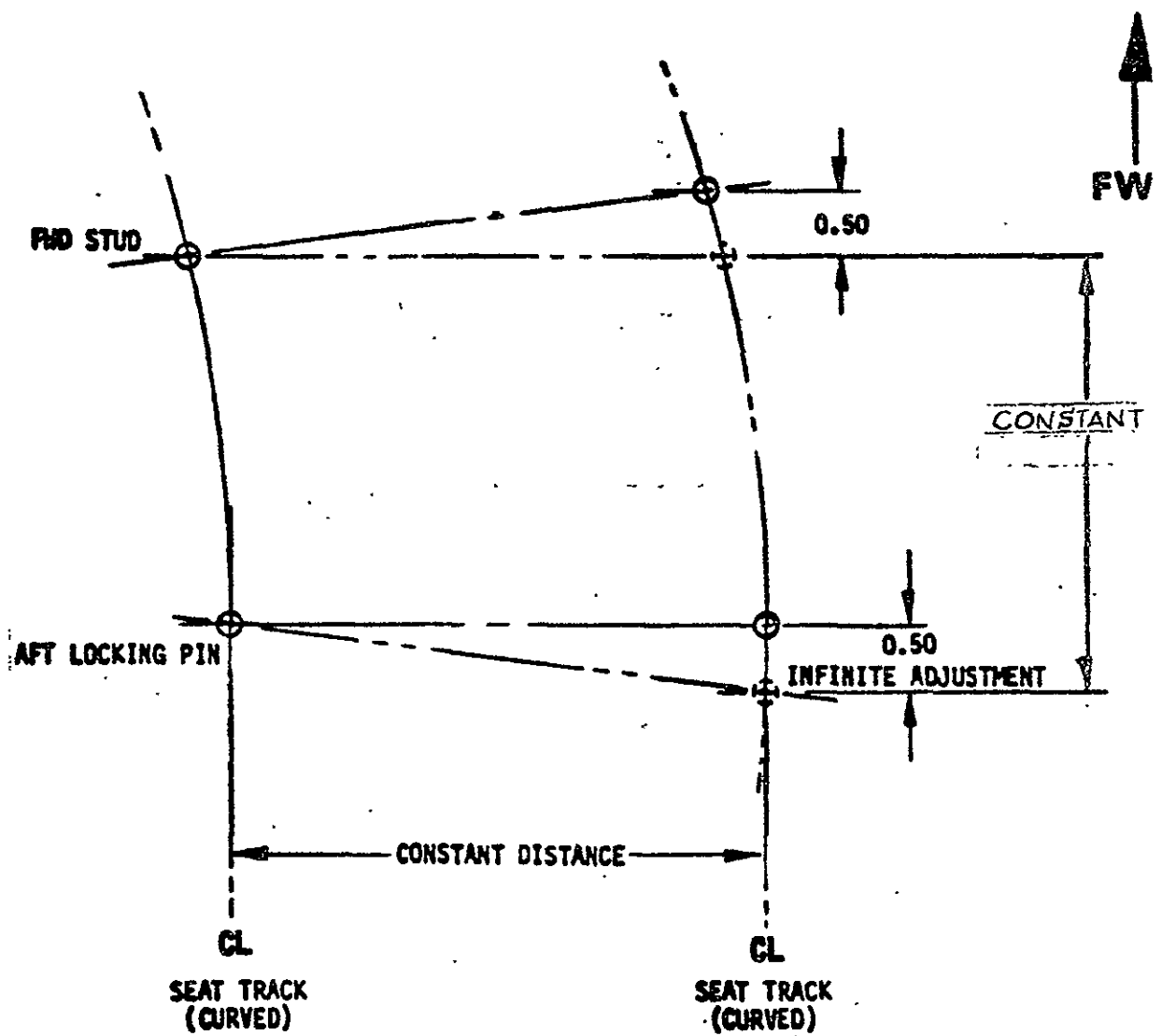


FIGURE 1. DESIGN CONSIDERATION FOR PASSENGER SEAT ASSEMBLY ATTACHMENTS TO A/C FLOOR-MOUNTED CURVED SEAT TRACKS

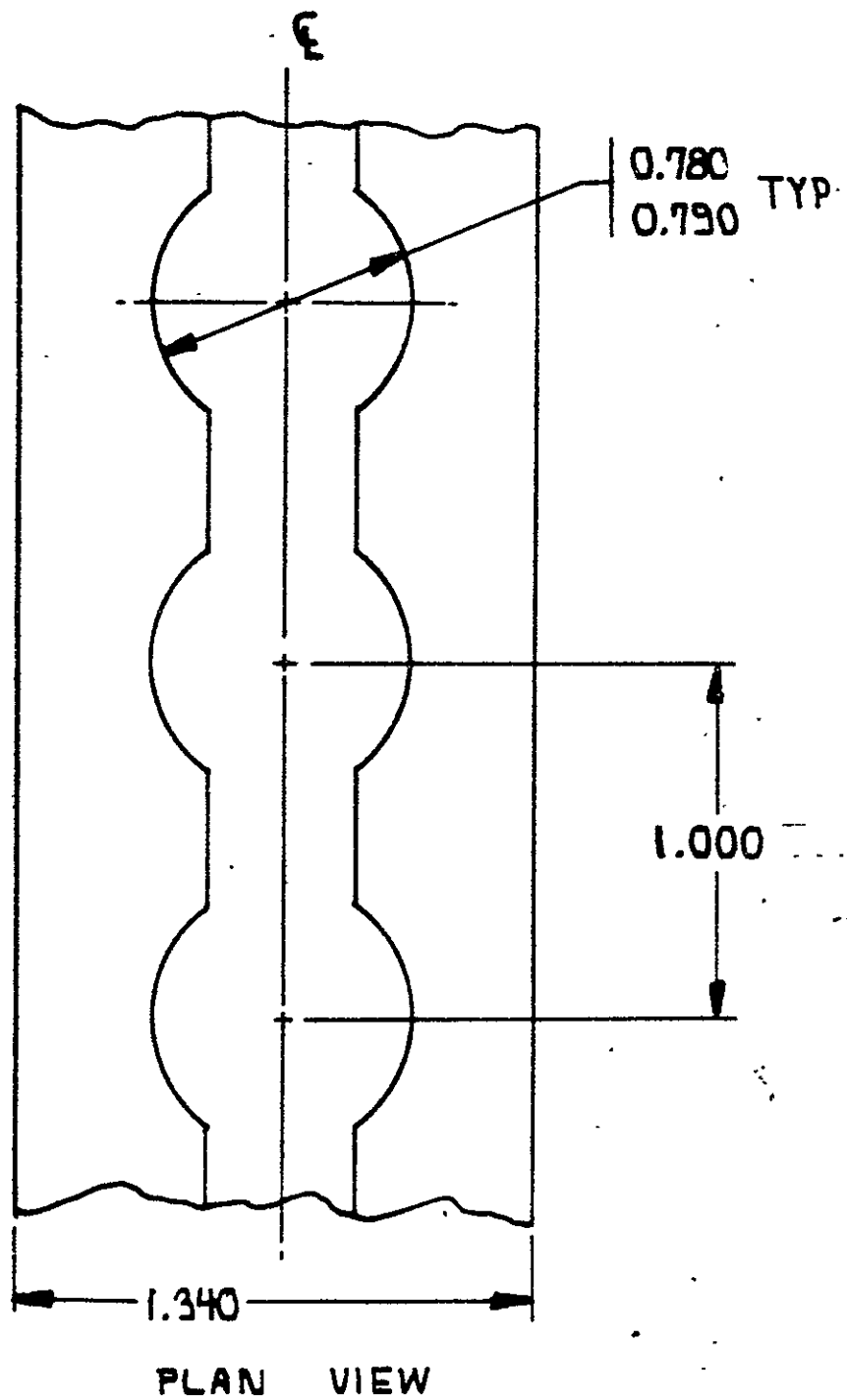


FIGURE 2. CRITICAL DIMENSIONS OF
AIRCRAFT SEAT TRACK
HARDWARE (TYPICAL)

3.3.1.5

Critical Loading of Airframe Structure

The maximum seat weight is critical weight which shall not be exceeded because of airframe structure limitations. The weight shall be 230 pounds (or less) per passenger place. With this value based on 8-abreast seating, compensation shall be made for 9-abreast seating by reducing the weight as required.

Weight distribution shall be as follows:

- a. Basic Seat Weight TBD
- b. Baggage 20 pounds per passenger place
- c. Occupant 170 pounds each
- d. All other items which are not included in seat weight per Table II
- e. Personal items, such as life vests, pneumatic headsets, literature, and other similar items.
- f. Utility cabinet Reference paragraph 3.4.3

3.3.1.6

Acceptable Track Fittings

The following seat attach fittings have been tested in appropriate seat tracks under ultimate load conditions and have an acceptable fitting/track interface for their intended installation:

- a. Ancra P/N 40426-11
- b. Ancra P/N 40363-10, -13
- c. Ancra P/N 40594-11
- d. Ancra P/N 40659-10, -11
- e. Aerotherm P/N 69098
- f. Hardman P/N 105008
- g. Sabre Part No. 500320-1, -3, -4

Only these tested fittings or their equivalent may be used. Equivalency will be determined by the buyer.

3.3.3

Electrical Requirements

3.3.3.1

Electrical Wiring

Wiring, wire routing, and wiring installation of the electrical system(s) of the passenger seat assemblies shall conform to the requirements of the applicable aircraft specification.

3.3.3.2 Electromagnetic Interference Suppression

Electrical/electronic equipment of the passenger seat assemblies shall not exhibit electromagnetic interference characteristics beyond the limits allowed by the applicable aircraft specifications.

3.3.3.3 Electrical Bonding

All passenger seat assemblies shall provide electrical bonding between elements of the seat assembly; this shall preclude any high resistance path for stray electrostatic charges to ground, and/or high resistance points within the passenger seat assembly electrical system(s).

A pin will be provided at the demultiplexer/encoder interface connector where all hazard bond paths of the seat assembly shall be terminated.

The passenger entertainment/service multiplex system shall "collect" the electrical bonds of all seat assemblies and provide a conduction path to the aircraft structure.

Incidental bonding that may exist between the seat assembly legs and the seat tracks is desirable but not mandatory.

Above bonding requirements shall meet the applicable aircraft specification.

3.3.4 Detail Requirements

Platform-mounted seats shall be designed with a minimum of 3/8 inch clearance between top of floor and underside of the platform. Each passenger seat assembly shall incorporate as a minimum the items listed in Table II.

3.3.5 Breakover

For passenger safety, seat backs shall breakover with resistance to the travel limit shown in Figure 16 (suggest an initial motion resistance of 25-35 lbs to applied force at top of seat back). Further breakover may be accomplished by manual means for maintenance and packaging.

3.4 PASSENGER SEAT COMPONENTS

3.4.1 Seat Recline Control

Seat assemblies having recline capability shall incorporate means to limit the degree of maximum recline. This is to permit reduced seat spacing when desired or to eliminate interference with installations behind rear seat rows.

3.4.2 Lap Belt

There shall be one lap belt assembly per passenger place. Attachment fittings shall meet FAR 25.625 requirements. Lap belts shall meet the requirements of FAR 37.136 (TSO-C39z), FAR 37.132 (TSO-C22), and FAR 25.853.

3.4.3 Utility Cabinet

The utility cabinet, when used, shall be located on the aircraft centerline between seat assemblies. The cabinet shall permit attachment to either the structure of adjacent seats, or to the seat tracks at the aircraft reference point, as defined in the applicable aircraft specification.

The cabinet structure shall be designed to accept the acceleration loads (par. 3.3.1.4 and Table I) relative to the required capacity. The cabinet shall be designed to withstand an ultimate load of 400 pounds in the down direction, applied to the top center; and where the top is 30 or more inches above the floor as mounted in the aircraft, the cabinet shall be designed to withstand side, forward, and aft loads of 300 pounds applied to top center.

The cabinet shall be fabricated from self-extinguishing material that conform to FAR 25.853.

Restraint(s) for the contents of the utility cabinets shall conform to FAR 121589.

3.4.4 Emergency Oxygen System Compartment

The manufacturer shall provide as an installed part of each seat assembly an oxygen system compartment and air blower, as applicable, that structurally, dimensionally and functionally meets the requirements of the applicable aircraft specification.

3.4.4.1 Intended Use

The oxygen compartment door shall open upon electrical command and automatically present the emergency equipment to the passengers. Extreme care shall be taken to insure reliable presentation of the emergency oxygen equipment.

3.4.4.2 Wiring

All wiring and connectors for each individual air module and oxygen compartment door latch mechanism shall be installed by the manufacturer and shall terminate at the demultiplexer/encoder unit.

3.4.4.3 Compartment Locations

Emergency oxygen compartments shall be located in the seat backs as specified in the appropriate aircraft specification.

3.4.5 Placards

Placards as required by FAA shall be installed. This does not preclude special manufacturer placards that meet FAA requirements. Any seat identification placards must agree with seat row placards installed by the aircraft manufacturer.

3.4.6 Passenger Entertainment/Service Multiplex System

Each of the seat assemblies shall incorporate complete provisions for the installation of an electronic unit, hereinafter called the demultiplexer/encoder. The unit is part of the passenger entertainment/service multiplex system (P.E./P.S. multiplex system). The entertainment/service controls are to be incorporated into a passenger control unit (PCU) as a part of the seat, which is provided by the airline customer.

3.4.6.1 Demultiplexer/Encoder Unit

The demultiplexer/encoder unit shall be procured and installed by the manufacturer. A two-seat model for single and double-seat groups and a three-seat model for triple-seat groups are commonly used.

Quadruple seat assemblies shall employ two demultiplexer/encoders. The demultiplexer/encoder has three electrical connectors (J1, J2, J3). The first two provide interface with adjacent fore and aft seats, and may be used interchangeably. J3 connects the electrical power and signals to all sub-assemblies within the seat.

3.4.6.1.1 Accessibility and Installation

The seat shall include space provisions which allow access to the demultiplexer/encoder through a hinged door which is provided with a latch that can be opened by a screwdriver.

Sufficient access shall be provided to the multiplexer/encoder unit through the shroud door opening to permit easy hand-installation and replacement of the unit, and for quick and easy hand-coupling and uncoupling of the three electrical connectors.

The demultiplexer/encoder shall be protected from materials that are usually handled by passengers and maintenance personnel.

The mounting provisions for the demultiplexer/encoder shall meet the requirements shown in Figure 3. These provisions shall be compatible with the standard cable lengths specified in paragraph 3.4.6.3.a.

The demultiplexer/encoder is provided with four positive locking fasteners and also with mounting holes that may be used, at customer option, with standard No. 10 screws (see Figure 3).

3.4.6.1.1 Accessibility and Installation (continued)

Both models of demultiplexer/encoder units are constructed so that a three-seat model may be used in a two-seat group, but an index block shall be provided in the seat if a three-seat model is used, to prevent the use of a two-seat model in a triple seat.

3.4.6.2 Thermal Characteristics

The electrical power consumption is:

- a. Two-seat demultiplexer/encoder 4 watts maximum
- b. Three-seat demultiplexer/encoder 5 watts maximum

The electrical power is normally dissipated as heat. The heat is transferred to the surrounding environment, predominantly by natural air convection. The cavity enclosing the demultiplexer/encoder unit shall not prevent the natural circulation of air around the unit.

For reliable operation, the steady state heat transfer from the unit to the mass of air immediately adjacent to it (within the enclosure) shall not cause a temperature rise (in that surrounding environment) of more than 100C with respect to the aircraft cabin temperature with air conditioning in operation.

3.4.6.3 Cabling

The demultiplexer/encoder unit is connected with similar units in the adjacent fore and aft seat assemblies by corresponding cables. These multiconductor harnesses (one coaxial and ten wires) are herein referred to as "seat-to-seat cables."

The seat design must provide sufficient access for the installation and removal of the seat-to-seat cable. These requirements shall meet, or be compatible with the following physical characteristics:

- a. Standard seat-to-seat cable lengths, including connectors: 60 inches, 68 inches or 75 inches.
- b. Seat-to-seat cable diameter: 0.320 inch (MAX.)
- c. Seat-to-seat cable bend radius:
- d. Envelope of the connector plugs at both ends of the cable: Cross section width .75, height 1.00, length 1.40.

Also provisions shall be incorporated to preclude damage to the cable at entrance and/or exit points in the seat structure. Means shall be provided to adequately protect and support the cable leading from the sidewall disconnect, through the seat

3.4.6.3

Cabling

structure, to the demultiplexer/encoder unit. The provisions must avoid sharp edges along the cable route and use materials of suitable finish to conserve the integrity of the cable.

When installed in the aircraft, the portion of the harness between two adjacent seat assemblies lies in the seat track cavity provided for such effect. In all cases, the seat-to-seat cable is routed along the right side seat-track. As the cable reaches the seat assembly, it comes out of the track through a grommet for support and protection. The seat assembly shall have adequate provisions to route the remaining length of the harness up to either connectors J1 or J2 of the demultiplexer/encoder unit.

There are up to four (4) seat columns in each of the three passenger cabin compartments. A total of twelve (12) columns interface with the P.E/P.S. multiplex system at the corresponding aftmost seats. A seat column is determined by the group of seat assemblies aligned in the longitudinal direction of the airplane (fore-aft), between cabin doors.

The seat-to-seat cables connected to the demultiplexer/encoders along any given seat column determine a transmission line.

In any given seat column, the total length of the transmission line must not exceed 110 feet. For this purpose, the length of the transmission line is measured from either the partition or sidewall disconnect, as applicable, to the forward-most seat assembly in that column. The total length is determined by multiplying the individual length of the seat-to-seat cable (60, 68 or 75 inches) times the number of cables required in the column.

The Fwd Cabin Inboard Seat Columns require special provisions; which are contained in the applicable aircraft specifications. The 3 left outboard seat columns also require special provisions.

3.4.6.4

Passenger Control Unit (PCU)

One PCU shall be provided for each passenger place. The PCU shall contain service controls, entertainment controls, acoustic transducers and earphone jacks as required.

The design, manufacture and quality of the PCU shall be in accordance with established industry practices and meet all requirements set up by this specification and the applicable aircraft specifications.

3.4.6.4.1

Seat Wiring and Connector

The seat wiring harnesses shall be provided with suitable connectors, to be compatible with the aircraft systems.

3.4.6.5

Controls and Outlets

The exposed face(s) of the PCU may contain one or more of the following controls, switches, and outlets provided for passenger operation.

- a. Switch, Call/Reset Passenger-to-Attendant Call (Paragraph 3.4.6.5.1).
- b. Switch, Remote Control, Reading Light (Paragraph 3.4.6.5.2).
- c. Switch, Channel Select, Music/Movie Sound (Paragraph 3.4.6.5.3).
- d. Control, Volume, Music/Movie Sound (Paragraph 3.4.6.5.4).
- e. Outlet, Acoustic Transducer, Plug-in Connection for Pneumatic Type Headsets. (Paragraph 3.4.6.5.5).
- f. Outlet, Headphone Jack, Plug-in Connection (Paragraph 3.4.6.5.6).

These configurations are intended to show all types of components that can be used. Other configurations are possible, provided the individual components meet the requirements listed in the following paragraphs.

3.4.6.5.1

Switch, Call/Reset (Passenger-to-Attendant Call)

This function shall be performed by a momentary-action switch normally open, pull-to-call and push-to-reset or vice versa. "Normally open" shall be interpreted as an impedance of 10 megohms minimum between contacts.

When the switch is pulled or pushed, the applicable pair of contacts shall be closed.

Pulling or pushing the switch to originate a "call" command will require a closed circuit (10 ohms maximum) from the call line to the PCU common. Pushing or pulling the switch to originate a "reset" command will require an impedance of 22 Kohms ($\pm 5\%$ initial manufacturing tolerance, $\pm 10\%$ end of life tolerance) 1/8 W from the call line to the PCU common.

Call line is the designation given to the wire connecting the switch to the demultiplexer/encoder. The following logic patterns are possible:

3.4.6.5.1 Switch, Call/Reset (Passenger-to-Attendant Call)

<u>Switch Position</u>	<u>Impedance</u>	<u>Action</u>
1. Pulled Out	10 Ohms Max. (Closed Circuit)	Call
2. Normal	10 Mohms Min. (Open Circuit)	None
3. Pushed In	22 Kohms $\pm$ 10% 1/8 W	Reset
4. Pulled Out	22 Kohms $\pm$ 10% 1/8 W	Reset
5. Normal	10 Mohms Min. (Open Circuit)	None
6. Pushed In	10 Ohms Max. (Closed Circuit)	Call

The reset capability of the switch may be deleted if the aisle reset switch(es) is (are) used. (See Paragraph 3.4.6.6).

3.4.6.5.2 Switch, Remote Control, Reading Light

The remote control of the reading light shall be performed by a switch, either momentary or latch type. If a momentary type of switch is used it shall be single-pole, single throw, normally open and momentarily closed. That is, upon a push or a pull (whichever is desired) the switch contacts must be closed, connecting the PCU common to the encoder circuitry. This will be interpreted as a change status for the corresponding reading light. The normally opened state will cause no action. The push-on/push-off button type is acceptable.

~~The momentary switch assumes the use of the electronic memory within the furnished P.E./P.S. multiplex system. This memory consists of an energy storage device that prevents the electronic memory from changing its state when power interruptions for as long as 200 m.sec take place.~~

If the latch type of switch is used it shall be two-position, single-pole, double-throw; opened for OFF command and closed for ON command. Because this type of switch constitutes the use of a mechanical memory, the reading light status is affected only momentarily by power transients. Both types of switches use the same wire for connection to the demultiplexer/encoder unit.

As previously stated, "closed circuit" shall be 10 ohms maximum whereas, "open circuit" shall be 10 ohms minimum.

3.4.6.5.3 Switch, Channel Select, Music/Movie Sound

The channel selection method of the P.E./P.S. multiplex system uses three wires or lines (designated 2, 4 and 9) to connect the demultiplexer/encoder unit and each PCU.

The maximum number of programs (namely switch positions) that can be selected is twelve (12). Also, the P.E./P.S. multiplex system has the capability of providing PCU continuity check as an optional feature of the built-in-self-test.

3.4.6.5.4 Control, Volume, Music/Movie Sound

A volume control shall be included in the PCU to adjust the audio level. The volume control shall consist of a variable resistor in each of the two audio lines (A and B). The variable resistor may be connected either in parallel or in series with respect to the transducer. Controlling the two lines separately, with two knobs or together in tandem with one single knob, is acceptable as are continuous or stepped variations.

3.4.6.5.5 Outlet, Acoustic Transducer, Plug-In Connection for Pneumatic Type Headsets.

An acoustic transducer with plug-in connections for pneumatic type headsets shall be installed for each individual seat when entertainment functions are provided. The transducer shall be dual with one channel for each ear. The transducer may be an integral part of the PCU.

3.4.6.5.6 Outlet, Headphone Jack, Plug-In Connection

Plug-in connections for dynamic or magnetic headphones may be provided at each individual seat. The phone jack may be an integral part of the PCU, or external to it.

If provisions are incorporated for the use of low impedance headphones (dynamic or magnetic), a resistor shall be connected in each audio line, in series with the jack. This resistor may be combined with the one mentioned in the previous paragraph. Its value may take into consideration the headphone impedance and, if applicable, the transducer efficiency, but it shall comply with the 150 ohms minimum load requirements at all frequencies from 50 Hz. to 10,000 Hz.

The headphone jack shall be installed in parallel with the transducer. The jack may be installed in such a way that the insertion of the headphone plug will simultaneously open the acoustic transducer branch. Incorporation of transformer coupling is also acceptable.

3.4.6.6 Aisle Call Light

Call requests of the Passenger-to-Attendant Call function shall be indicated on a (two) light(s) located at one (both) side(s) of each assembly, and be designated "Aisle Call Light(s)".

Two operational modes are possible as follows:

a. First Class Inboard Seats

It provides independent action for right and left seats. A call request originated at the right seat will turn ON the aisle call light at the side of the right seat. Reset of that call may be done only at the right seat reset switch. Call requests originated at the left are similar.

b. All Seats, Except First Class Inboard Seats

It provides combined action for the entire seat assembly. A call request originated at any seat of assembly will turn ON both aisle call lights. Resetting may be done by actuation of any reset switch in the seat assembly.

3.4.6.6.1 Aisle Call Light Characteristics

The aisle call light(s), located at the seat side(s) shall be of the neon type. Power provided for the light will be 115 VAC, 400 Hz, half-wave rectified.

The external current limiting resistor connected in series with the lamp shall be 18 Kohms min., $\pm 5\%$ initial tolerance, $\pm 10\%$ end-of-life, 1/2-watt.

3.5 DC-10 Passenger Seat Configurations

Both coach and first-class passenger seat configurations shall meet the general design parameters.

3.6 Environmental Requirements

3.6.1 Fire-Hardening Requirements

The data upon which the fire-hardening requirements of this specification are based were developed during an extensive test program conducted by the Douglas Aircraft Co. under NASA Contract NAS 2-9337. As a result of this test program improved methods and processes have been developed for the construction of commercial aircraft passenger seats.

3.6.1.1

Seat Frame

The seat frame shall be constructed using current state-of-the-art, contemporary methods and procedures; and the dimensional data contained elsewhere in the specification and the applicable aircraft specification. In addition, the seat frame shall consist of a seat pan and the seat back panel of stainless steel sheeting not greater than 0.015 thick. These panels will provide the platform for the attachment of the seat and back cushion. Further these panels shall be attached to the seat frame in such a manner that the load carrying and strength capabilities of the seat is not degraded.

3.6.1.2

Seat Cushions

The seat cushion shall be constructed to consist of two or more layers as follows:

Decorative fabric layer, slip sheet layer, fireblocking layer, reinforcing layer, cushioning layer(s), and appropriate adhesive layers.

Each of the design incorporated layers shall meet the material requirements for that layer as specified in paragraphs 3.6.1.2.1 through 3.6.1.2.5.

3.6.1.2.1

Decorative Fabric Layer Requirements

The decorative fabric layer shall be rated excellent or good when exposed to 40 standard fade hours per FTMS No. 191 Method 5660. It shall meet a smoke generation maximum of 100 for the first 90 seconds and 150 for 90 seconds to 4 minutes when tested in flaming and non-flaming conditions per NBS Technical Note 708 and shall meet burn requirements of FAR 25.853(b) Amendment 25-32. When tested in abrasion with the contacting layer of material the breaking strength of the decorative material shall have a maximum reduction of 10% after testing for 20,000 cycles per the Wyzenbeck Method per FTMS 191, Method 53.04.1. The decorative fabric when pyrolyzed shall produce no unusual toxic gases.

3.6.1.2.2 Slip Sheet Layer Requirements

The slip sheet layer shall meet a smoke generation maximum of 40 for the first 90 seconds and 40 for 90 seconds to 4 minutes when tested in flaming and non-flaming conditions per NBS Technical Note 708 and shall meet burn requirements of FAR 25.853(b) Amendment 25-32. When tested in abrasion with the decorative fabric layer per paragraph 3.6.1.2.1 the breaking strength shall have a maximum reduction of 10% after abrasion testing. When pyrolyzed the slip sheet layer shall generate no unusual toxic gases.

3.6.1.2.3 Fire Blocking Layer Requirements

Fire blocking layer materials shall meet a smoke generation maximum of 100 for the first 90 seconds and 150 for 90 seconds to 4 minutes when tested in flaming and non-flaming conditions per NBS Technical Note 708 and shall meet burn requirements of FAR 25.853(b) Amendment 25-32. When tested for heat release at a flux of 3.5 w/cm^2 the total heat release after 1.5 minutes shall not exceed 30 kw/m^2 . Testing shall be per Phase II Report Appendix 8.3. The material when pyrolyzed shall generate no unusual toxic gases.

3.6.1.2.4 Reinforcing Layer Requirements

The reinforcing layer shall meet all the requirements of the slip sheet layer per paragraph 3.6.1.2.2.

3.6.1.2.5 Cushioning Layer Requirements

The cushioning layer when tested at 3.5 w/cm^2 for heat release shall not exceed 50 kw/m^2 after 1.5 minutes and 150 kw/m^2 after 10 minutes. The material shall meet a smoke generation maximum of 130 for the first 90 seconds and 230 for 90 seconds to 4 minutes when tested in flaming and non-flaming conditions per NBS Technical Note 708* and shall meet burn requirements per FAR 25.853(b) Amendment 25-32. When pyrolyzed the cushion material shall give off no unusual toxic gases.

3.6.1.2.6 Adhesive Material

The adhesive shall meet a smoke generation maximum of 20 for the first 90 seconds and 30 for 90 seconds to 4 minutes when tested per NBS Technical Note 708 in the flaming and non-flaming mode and shall meet burn requirements when brushed on glass cloth (style 181) and tested per FAR 25.853(b) Amendment 25-32. When tested for weight loss at temperature (T6A) per Phase II Report Appendix 8.3 the maximum weight loss shall not exceed 20%.

3.6.1.2.7 Sewn Seams

Sewn seams shall be a single felled seam with three stitches. The thread shall be fiberglass coated with teflon.

3.6.1.2.8 Multilayer Seat Cushion Requirements

A sample 10" x 10" x thickness, consisting of each of the design selected layers in order with a 1 inch thick cushion layer shall be tested for heat release per test method in Phase II Report Appendix 8.3. The sample shall be tested at 3.5 w/cm². The maximum heat release at 1.5 minutes shall be 60 kw/m² and the maximum heat release after 10 minutes shall be 225 kw/m².

Reference:

National Bureau of Standards (NBS) Technical Note 708 "Inter-laboratory Evaluation of Smoke Density Chamber," December, 1971. Appendix II "Test Method for Measuring the Smoke Generation Characteristics of Solid Material," dated September, 1971.

3.6.2 Vibration/Shock

Shock and vibration requirements for equipment components, located in various zones of the airplane, are defined in the appropriate aircraft specification. Passenger seat assemblies are considered to be components of the airplane and should meet the applicable load levels.

3.6.3

Altitude

Passenger seats shall be designed to withstand explosive stresses resulting from rapid decompression (5,000 to 42,000 feet, mean sea level reference); alternatives are adequate venting of entrapped air, or absence of such entrapment. Electrical equipment shall be designed to operate within specified parameters up to 42,000 feet above mean sea level. Dielectric strength of all electrical insulation shall be designed to prevent corona effects and voltage shorts across gaps between terminals and other points of high stress and/or ground.

3.6.4

Humidity

Passenger seats shall be designed to withstand 95 percent humidity including periods of condensation at 68 to 160 degrees Fahrenheit without undue degradation of material and/or performance.

3.6.5

Explosive Atmosphere

Passenger seats shall be designed so that all equipment, such as switches, circuit breaking devices and other high-temperature energy sources, are guarded to the extent that their operation will not ignite an explosive atmosphere. Any atmosphere of optimum fuel-air mixture that requires the least amount of energy (electrical, thermal, and/or chemical) for ignition shall be considered an explosive atmosphere. Examples of materials likely to be within cabin passenger-seat areas which could generate explosive atmospheres by spillage, or inadvertent release are alcoholic beverages, aerosol mixtures (hair spray, lacquer-type), and lighter fluid.

3.7

Documentation

3.7.1

Drawings

To ensure proper fit and to allow preparation of installation drawings, sufficient drawings shall be furnished to the buyer at least 120 days prior to delivery of the first assembly to show the following:

- a. Overall dimensions
- b. Leg locations
- c. track stud locations
- d. Track locking (shear) pin locations
- e. Seat center of gravity (height dimension)
- f. Utility cabinet
- g. Plug-in utility food tray
- h. Utility cabinet (See Figure 18) and plug-in utility food tray drawings to provide sufficient detail to allow determination of compliance to FAA requirements and to allow preparation of Douglas Installation drawings.
- i. Seat base dimensions to provide sufficient detail to allow preparation of floor covering installation drawings. See Figure 19.
- j. Profile views of seats, including stowage compartment and partition behind seats as illustrated by Figure 16. Seat dimensions shall be applied to permit a Douglas check for clearances behind the seats. Dimensions shall include location of the seat back pivot point, pivot point to rear of seat back and sufficient dimensions to define the contour of the most rearward fixed portions of the seats.

3.7.2

Approval Data

The following shall be furnished to the buyer.

- a. Composite drawings showing the emergency oxygen system compartment dimensions, dimensional tolerances, installation of hardware, etc., for installing the oxygen equipment and fan module.
 - b. Passenger control unit, envelope, installation details and internal schematics.
 - c. Installation, electrical and mechanical characteristics of the aisle call lights.
 - d. Wiring diagrams of the interface between all electrical components within the seat assembly.
 - e. List of components and materials of all electrical sub-assemblies installed in the seats.
 - f. Test procedure for functional acceptance of the PCU.
 - g. Qualification test procedure and test report of the PCU.
 - h. Test procedure for acceptance of the seat assembly, including wiring continuity.
 - k. Qualification test procedure and test report of the seat assembly. Including FAA, FAR & CAR documentation.
 - l. Qualification test procedure and test report for the emergency oxygen system compartment.
-
- m. Acceptance test procedure for each installed emergency oxygen system compartment.
 - n. List showing all deviation requests, and their status. Reference Paragraph 1.6.

4.0

QUALITY ASSURANCE REQUIREMENTS

4.1

Conformance

Seats will be inspected by the buyer for conformance to interface requirements.

4.1.1

Qualification Testing

The buyer shall submit documentation to substantiate conformance to performance requirements of paragraphs:

- A. 3.1 c Non-Metallic Burn Requirements

4.1.1 Qualification Testing (Continued)

- B. 3.1 d : Smoke Density Ratings
- C. 3.1 c FAA Requirements
- D. 3.3.1.4 Acceleration
- E. 3.3.3.1 Electrical Wiring
- F. 3.3.3.2 Electromagnetic Interference Suppression
- G. 3.4.2 Lap Belt
- H. 3.4.4 Emergency Oxygen System Compartment
- I. 3.6.1 Fire-Hardening Requirements
- J. 3.6.2 Vibration/Shock

4.1.2 Acceptance Testing

4.1.2.1 Acceptance Test Plan

The manufacturer shall submit applicable documents for the buyers approval. The documents shall include, as a minimum, acceptance test plan and procedures for the Passenger Control Unit (Paragraph 3.4.6.4. and Subs), seat interface wiring (Paragraph 3.4.6.3 and Figure 7) emergency oxygen system compartment per Paragraph 3.4.4 and related electrical components within the seat assembly.

4.1.2.2. Acceptance Test

All seats shall be inspected for fit, form and function.

Seats which will be installed adjacent to a sidewall shall be checked in a fixture which simulates the sidewall panel to ensure positive sidewall clearance. Seats that do not conform shall be returned to the manufacturer.

4.1.2.2.1 Emergency Oxygen System and Compartment

The acceptance plan and procedures shall include a procedure for testing the emergency oxygen system compartment and wiring. The test shall be performed on each seat containing an oxygen compartment.

6.0

NOTES:

6.1

Space Orientation References

All space orientation references for seat assemblies manufactured to the requirements of this specification, such as fore, aft, left, right, inboard, outboard, and other similar terms, are related to aircraft relationships of installed equipment.

6.2

Definition of Terms

a. Coordination Drawing

A coordination drawing is one prepared by the buyer for the manufacturer which specifies interface requirements between the components and the aircraft and defines minimum design requirements.

b. Critical Structural Part

A critical structural part is one whose failure alone would endanger the airworthiness of the airplane, or the safety of its occupants or the ground crew.

c. FAA

Federal Aviation Administration

d. FAR

Federal Aviation Regulations

~~e. First Article Inspection (FAI)~~

~~The first article meeting specification requirements for a production article that is delivered by the manufacturer for the buyer inspection and acceptance; this article shall be fully certified for use in a delivered aircraft.~~

f. Loose Parts

Any unattached part delivered with the seat or parts that must be removed and reattached during the seat installation.

g. MAC

Military Airlift Command

h. Production Article

Any article that meets all specification requirements regardless of method(s) of fabrication.

Definition of Termi. Prototype Article

An article that meets envelope, functional, and operational requirements that permit demonstration of concept and installation of all equipment specified by "complete provisions for"; the article need not meet strength and material specification requirements.

j. Source Voltage

Source Voltage is the voltage available at the generating source as specified in the design specification document.

k. Substantiation

Verification

l. Ultimate Factor of Safety

The ultimate factor of safety is the specified factor used for the determination of the design ultimate load.

m. Ultimate Load (Design)

The design ultimate load is a load equal to the product of the limit load multiplied by the specified ultimate factor of safety.